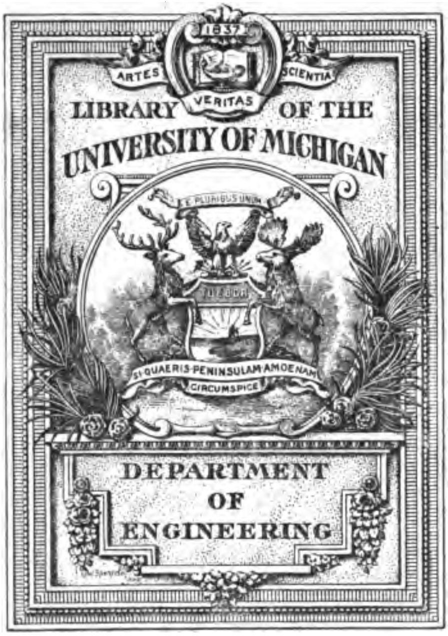
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OF
ENGINEERING

ELECTRICAL CONTRACTING

SHOP SYSTEM, ESTIMATING, WIRING CONSTRUCTION METHODS, AND HINTS ON GETTING BUSINESS

BY

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PREFACE.

This volume was written for the wireman and contractor, with a view to giving him, not only some practical hints on latest construction methods, but also to suggest to him means for increasing his income.

Many special devices have been described, which may suggest to the contractor, an "extra" which he may sell his customer.

For those about to embark in the electrical contracting business as well as the established contractor, the system of accounting described may suggest means for detecting financial leaks, as well as for systematizing the accounts.

Only devices and wiring methods approved by the underwriters have been described. The underwriters' rules have not been included in this volume, as they can be obtained free of charge from either the New York, Boston or Chicago offices of the National Board of Fire Underwriters.

L. J. A.

New York, June 1, 1908.

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ELECTRICAL CONTRACTING

CHAPTER I.

SHOP SYSTEM FOR ELECTRICAL CONTRACTORS.

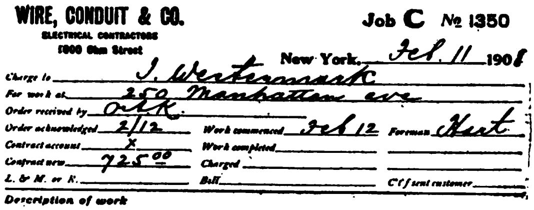
THE shop and accounting system of any electrical contracting business very naturally varies according to the amount of business done, so that it is out of the question to give a system which is applicable to all cases. That described herewith is suitable for a concern doing a general contracting and jobbing business and employing from 15 men upwards. The system is simple and accurate, and the forms used are the result of a gradual development. They are designed to avoid the cumbersome detail common in many record forms, and have been evolved with the life of a number of concerns who make a daily use of them.

The orders, or contracts, received are divided into two classes; those in which a contract for a stated price has been made, and those classed as time and material jobs.

As an example, a contract for wiring a house at a price of $725 is received. The original order or contract, properly signed, is filed in a special file, which should be kept in a safe. The order is entered, in duplicate, on a blank form (Fig. 1). One copy is given to the foreman and the other is kept in the book. The orders are consecutively numbered, and the contract is then known as Job. No. C1350. The price is not put on the copy given to the foreman, as it is not considered good policy to have the prices of contracts generally known except to the firm.

The foreman is expected to learn the exact nature of the work, either from verbal description or specification. He then makes a list of the material needed to start the job. This may be done from an analysis of the estimate, or,

better still, by an inspection of the building in which the work is to be performed. The foreman then fills out a "material slip" so that the stock clerk can get the materials promptly to the job. Such a slip is shown in Fig. 2.



WIRE, CONDUIT & CO.
ELECTRICAL CONTRACTORS

Job C № 1350

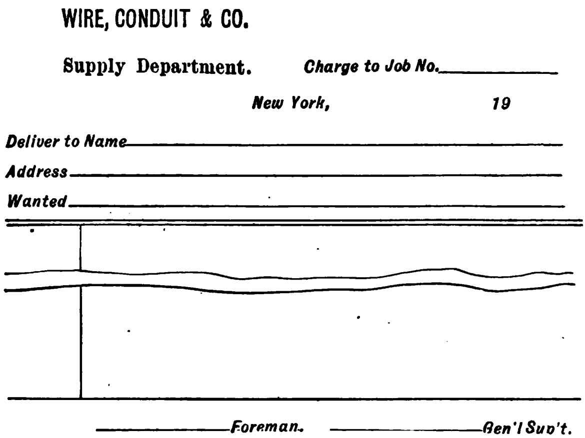
New York, Feb. 11 190

Charge to J. Westermark
For work at 250 Manhattan ave
Order received by
Order acknowledged 2/12
Work commenced Feb 12
Foreman
Contract account X
Work completed
Contract new 725.00
Charged
L. & M. or E.
Bill
C'f sent customer
Description of work

FIG. 1.— Actual size, 9 inches wide by 8 inches high.

The stock clerk should be prohibited from filling any orders unless the job number is on the requisition, as well as the signature of the foreman or other authorized person.

These orders, after being filled, should be carefully filed



WIRE, CONDUIT & CO.

Supply Department. Charge to Job No.

New York, 19

Deliver to Name
Address
Wanted

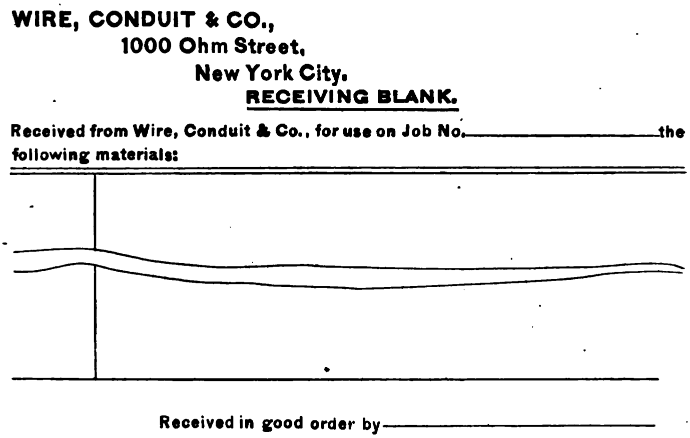
Foreman. Gen'l Sup't.

FIG . 2. — Actual size, 6 inches wide by 8 inches high.

so that all slips for one job are together. A good way of doing this is to fasten them into a blank book by pasting the slips on pages corresponding in numbers to the job numbers. In case there are a number of slips for one

number, these may be pasted over one another by gumming the edges.

The getting of the proper material promptly on the job is one of the important duties of the stock clerk. He should promptly notify the foreman of any unlooked-for delay, so that workmen are not kept waiting for the necessary material. The cost of errand boys and proper wagon service should not be stinted, as delays in receiving materials promptly cause a considerable leak in the profits. The stock clerk



WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.
RECEIVING BLANK.

Received from Wire, Conduit & Co., for use on Job No.________________ the following materials:

Received in good order by________________

FIG. 3. — Actual size, 6 inches wide by 8 inches high.

should insist upon getting a proper receipt from the foreman or wireman on the job, for materials delivered. (See Fig. 3.)

Foremen and wiremen should be instructed to measure for special fittings as soon as practicable, so that the material may be on hand when needed. This refers especially to panels, trims, switch-plates and all fittings not regularly carried in stock.

Should any extra orders be obtained in a contract job, the order for same should be entered on a separate blank. If the extra is obtained at a stated price, blank form, shown in Fig. 1, is used.

Many extra orders are usually received verbally; they

should be acknowledged at once, stating prices and the work to be performed. This will make the settling of the

WIRE, CONDUIT & CO. Job R No. 7494
ELECTRICAL CONTRACTORS
1000 Ohm Street New York, Feb. 11 1908

Gentlemen—Please furnish the material and perform the labor for the following work to be done at 250 Manhattan ave
and charge same to the account of J. Westermark
Terms ______ *Contract New* ______

Description of work *Order received by* ______
Repair broken circuit wire.

FIG. 4. — Actual size, 7 inches wide by 11 inches high.

account a simple matter, as any misunderstanding can be adjusted before the work is under way.

New York, 190

WIRE, CONDUIT & CO.
ELECTRICAL CONTRACTORS
1000 Ohm Street

Gentlemen: Please furnish the material and perform the labor for the work described below, at
Terms:
Labor to be charged at the rate of $ per day for journeyman and $ per day for helper.
And charge the same to the account of
Signature

Description of work:

Customers will please note that the time of workman is charged for from the time he leaves the shop until he returns, and a reasonable addition for foreman's time for supervision. Minimum charge one hour, and double time for overtime after hours Sundays or holidays.

FIG. 5. — Actual size, 7 inches wide by 10 inches high.

For all orders received on which no price has been set the accompanying blanks will be found suitable. In form shown in Fig. 4, a different letter is used before the number

to distinguish these orders from the stated-price jobs. These orders are made in duplicate, a carbon copy remaining in the book. When receiving such an order the customer should be told the price per hour for labor, and, if practicable, the prices per unit for material. If the order was given verbally, the customer should be asked to sign an order similar to Fig. 5.

The wireman should fill out the reverse side of the slip (see Fig. 6) and when finished with the work have it signed

MATERIAL USED

LABOR ACCOUNT

Name	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total	Rate			

Work satisfactory, time and material approved

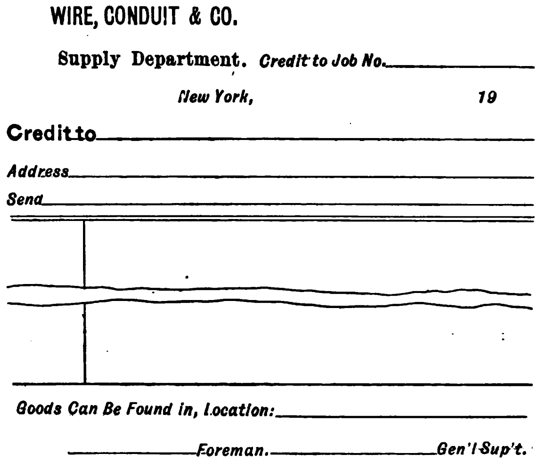
New York, ____________ 190 ____________________

FIG. 6. — Actual size, 7 inches wide by 11 inches high.

by the customer or his representative. This is a check for both the contractor and his customer, and prevents disputes when the bill is received. Time and material jobs, unless

properly handled, often lead to disputes. To avoid these, the customer should be advised as to the progress of the work and the approximate cost of the same. If any difficulties arise which will increase the price, he should be informed. The contractor should insist upon the customer, or his representative, checking the wireman's time, daily. Unless the customer is thus kept advised, much trouble may arise when the bill is presented, and customers are often lost, through no fault whatever on the part of the contractor.

When surplus material is returned from a job a proper return slip is filled out. (See Fig. 7.) This slip should be


WIRE, CONDUIT & CO.

Supply Department. *Credit to Job No.*

New York, *19*

Credit to

Address

Send

Goods Can Be Found in, Location:

Foreman. *Gen'l Sup't.*

Fig. 7. — Actual size, 6 inches wide by 8 inches high.

of a different color than the stock-requisition slips, to prevent errors in entering.

All orders, either contract (C) or labor and material (L and M), are indexed, to prevent the omissions of any slips when entering the charge. The bill clerk or bookkeeper should check them off as billed, or start a tracer for any missing orders before billing. (See Fig. 8, for index system.) When making out bills the slip numbers should

be placed on them. This makes it easy to look up slips should there be any disputes.

In keeping the cost of a job a loose-leaf book is best. The page should be numbered to correspond to the job number. The customer's name as well as details of the job should be on this sheet. In an iron pipe job the number

A

Anderson B.	C 121	L & M	546-732-826
Adams T.B.	C 162	L & M	930-1106-1108

Fig. 8. — Actual size, 5 inches wide by 3 inches high.

of outlets, switches, receptacles and panels should be given. These details should be copied from the specifications by the clerk who keeps the stock book and serve as a check on the material. If the original contract called for 24 switches and the sheet shows that 28 went out, a reason should be given for sending out the four extra switches. The form also serves to keep cost records per outlet, etc.

COST BLANK.

Name ______________ **No.** ______________

Date Started ______________ **Date Finished** ______________

Contract Price ______________ **Cost** ______________

Details:-

		Mdse.		Labor.	

Fig. 9. — Actual size, 8 inches wide by 12 inches high.

The cost books should have the material entered up daily and the labor weekly; the latter is taken from the time sheets. (See Fig. 9, for cost sheet.) The cost book will enable the head of the establishment to see the financial condition of every job, which is of great advantage, especially to check the progress of the contract. If the

cost is running unreasonably high, a conference should be had with the foreman in order to ascertain the reasons and apply the proper remedies.

The stock room should have a complete line of standard material, especially little fittings which are often required in a rush. Much money is also saved by buying goods in so-called standard packages. Where goods are ordered from supply houses or manufacturers a regular order blank should be used, and this should be the only means of obtaining goods. To be valid, the orders should be signed by

SEND INVOICE BY MAIL ON WHICH NUMBER OF ORDER MUST BE STATED
NOT RESPONSIBLE FOR GOODS DELIVERED WITHOUT PRINTED ORDER

Nº 2099

New York, ________ *19*__

M ________

Ship to ________

CHARGE TO ACCOUNT OF

WIRE, CONDUIT & CO.

PER ________

FIG. 10. — Actual size, 6 inches wide by 6 inches high.

one or two authorized persons. The job number should be on the order as well as the other information. (See Fig. 10, for order blank.)

Where materials are ordered to be shipped direct, the foreman or wireman on the job should fill out a slip (Fig. 11) when he receives such material. This enables the stock clerk to check the bill for material as to quantity and quality.

All supplies received should be entered in a receiving book so that the bills can be checked. (See Fig. 12, for receiving book.) When an order slip is turned in as completed the stock clerk should be notified so that he can promptly arrange to get back the unused material, ladders, scaffolds, etc. Unless this is carefully done much

material will be lost, as wiremen are usually very lax in bringing back unused material to the shop. A system for keeping track of ladders and special tools supplied to wiremen is necessary. A number of hooks are mounted

WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.

New York,__________

RECEIVED on account Job No.__________for contract of

____

from____________________the following material.

Signed____________________

FIG. 11. — Actual size, 6 inches wide by 8 inches high.

on a board, and these are numbered to correspond to numbers on ladders and tools. When a ladder is sent out a tag is filled out containing the job number, name of workman in charge, and date. This is placed on the hook corresponding to the ladder number, and is left there until the ladder is returned or shifted to another job. A similar system can be applied to pipe cutting and other special tools.

Our Order No	Received from	Located	By-what Route	Ch.g's	Rec'd by	Quantity	Description of Merchandise	Charge to	Bill Checked	Remarks

FIG. 12. — Actual size, 18 inches wide by 12 inches high.

Keeping employees' time records and checking the same is naturally one of the vital parts of any shop system. The names and addresses of all employees, together with their rating, such as apprentices, helpers and journeymen, should be noted in a book for that purpose. If the employee is discharged or laid off, a note should be made, together with the reason. If he is found to be proficient in a certain

TIME SHEET

Week Ending Jan 29 1908 Name of Workman R. K. Hart

Name of Customer and Job No.	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Total	Rate	EXPENSES—ITEMIZED
C 1350	8	8	4							Meals 15 ct
R 4780					8	8				
R 5051							8	44	4.00	

O. K. [illegible] Foreman. Approved [illegible] General Superintendent.

FIG. 13. — Actual size, 11 inches wide by 8.5 inches high.

line, that fact should also be recorded. Men are often laid off during slack times, and should the firm require a good man on iron pipe work, a search of the records will enable a postal to be sent to a number of the right kind of men.

A daily record of the disposition of the men should be kept so that the time sheets can be checked, and the numbers of the jobs they are on should be credited to them. If new L and M job slips are issued and assigned to a man, they should be charged to him.

Time sheets should show the employee's name, classification, rate of wages and daily record, and also expenses. (See Fig. 13, for time sheet.) An employee should fill out his own time sheet and have the foreman check same. It

should then be checked by the general superintendent or some one else in authority, who should use the daily time book for that purpose. The time sheets should be figured and entered in the time book by the bookkeeper. The time charged against the various jobs should then be entered on the cost sheets. All time charge on L and M order tickets should be compared with those tickets, as a check. This will show if it corresponds to the signed acknowledgment cf the customer. (See Fig. 6.)

The cost sheet of a finished job should be compared with the original analysis of the estimate. This will enable the

WIRE, CONDUIT & CO.,
1000 Ohm Street,
New York City.

FACTORY ORDER.

Foreman of Shop:-
Perform the following work on account of Job No.______
and when finished deliver to______________________

FIG. 14. — Actual size, 6 inches wide by 6 inches high.

estimating clerk to check up his work, and if a discrepancy occurs, say in labor, it should be brought to the attention of the proper party and an investigation made as to whether the job was poorly handled or the estimate was wrong. The cost sheet will serve as a check both ways.

If a contractor makes his own special fittings and fixtures, and does his own machine and carpenter work, a shop-order system is necessary. All material or work ordered from the shop should be ordered on a special blank. (See Fig. 14.) These blanks should be in duplicate and consecutively numbered.

On the reverse side (Fig. 15) the foreman notes the time, the materials used, and the cost. This will enable a proper record to be kept in the cost book, and also serve for fixing

the price to the customer. Where a large number of L and M sheets are made out, it is well to keep a record of them on a separate sheet. (See Fig. 16.) When the bill is sent out the amount is filled in on the sheet by the bill clerk, which shows that the final entry has been made.

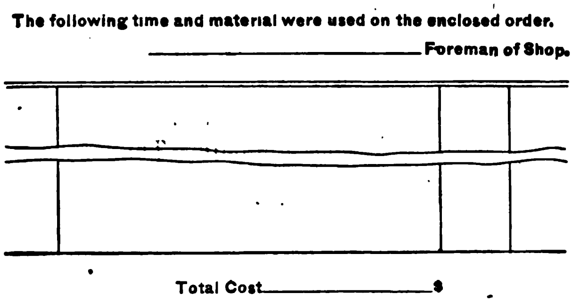


FIG. 15. — Actual size 6 inches wide by 6 inches high.

A good card index system for following up contract work is essential. Cards printed as per Fig. 17 are used. Space is provided for noting whether the service application to the local illuminating company has been made, if the application for inspection to the local inspection bureaus has been made, and also when the certificates were sent to the electric light company, and when returned. The job

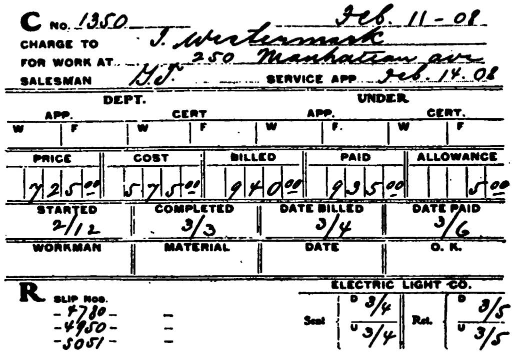
Job No	Name	Address	Credit to	Description of Work	Price	Workman	Start	Completed	Billed Amount

FIG. 16. — Actual size, 16 inches wide by 20 inches high.

number of all slips is also entered on the job, also the amount of same, and this is totalled when the job is finished. These cards are kept in three drawers of a card file and shifted as the job progresses. One drawer is labeled "Jobs Started," another "Jobs Completed," and the third "Bills Sent and Paid." These cards also serve as reference

for the head of the establishment, and for the collection department.

The departments of a contracting business are divided into the executive, accounting, operating, and sales. The executive department naturally directs the heads of other departments, and by consulting the office records can keep fully posted on all details of the business. The accounting department has charge of all accounts and the cost book. The head of the operating department is the superintendent. He should pass on all estimates and approve all the layouts



C No. 1350 Feb. 11 - 08
CHARGE TO J. Westermark
FOR WORK AT 250 Manhattan ave
SALESMAN H.J. SERVICE APP Feb. 14. 08

DEPT.				UNDER			
APP.		CERT		APP.		CERT.	
W	F	W	F	W	F.	W	F

PRICE	COST	BILLED	PAID	ALLOWANCE
725.00	575.00	940.00	935.00	5.00

STARTED	COMPLETED	DATE BILLED	DATE PAID
2/12	3/3	3/4	3/6

WORKMAN	MATERIAL	DATE	O. K.

R SLIP NOS. -4780- -4950- -5051-

ELECTRIC LIGHT CO.
Seal D 3/4 U 3/4 Rel. D 3/5 U 3/5

FIG. 17. — Actual size, 6 inches wide by 4 inches high.

of different jobs. He is responsible for the profitable and workmanlike results expected, and in large concerns has estimate clerks and draughtsmen to assist him. The foremen report to him, and he should be able to design any special fitting or device found necessary.

Foremen are assigned to districts and should visit all jobs at least once a day, for in no other way can discipline and a fair day's work be obtained from the working force. The foreman should see that proper tools, ladders, and material are on the job, and should instruct the workmen how to run their circuits as well as locate outlets, switches, bells, etc. He should order any special panels or other devices in time, so as not to delay the work. If violations

are filed oftener than reasonable, he should be discharged for carelessness.

The stock clerk has charge of the stock and the shipping of materials to the jobs. In this department none other than an active, energetic, and accurate man should be tolerated, as a careless stock clerk may cost the concern hundreds of dollars. To get the right material to the job quickly, and to order the special devices necessary, requires good judgment and experience. A big leak is possible in this department, and the stock clerk's records should be checked carefully.

The stock clerk should be held accountable for all material and tools, and an inventory should be taken at least twice a year. He should keep two files for the material slips; one for those filled and another for those unfilled. He should advise the foreman if he anticipates any undue delays in receiving material ordered, so that the foreman can govern himself accordingly. If the stock clerk finds that he cannot entirely fill an order for material, he should make out a due ticket similar to the form shown in Fig. 2, except that it should be of a different color and read on top "Due Ticket." The foreman can then see at a glance how many due slips there are and get after the stock clerk.

The sales department should have as many solicitors as are found profitable. In many cases the foremen are used as salesmen, and if they have the time it is a good plan. Workmen on the job, especially in private houses, make the best salesmen for extras, and if properly instructed will bring in considerable business. One salesman should look up the real estate transfers and removals. He should call on parties who have purchased houses and solicit business. If that branch of the work is sufficient to keep a man busy, another should solicit business among architects, builders, and decorators. A proper card "follow up" system, of which there are many on the market, should be used.

All requests for estimates should be turned over to the salesman who usually calls on that customer, if it be an

old account; if not, the salesmen should be consulted to see if they know the party or anyone having influence in that direction.

At certain times in the year removals are frequent and placards in the windows of stores announce the intended removal to other quarters. A call on such parties frequently results in orders.

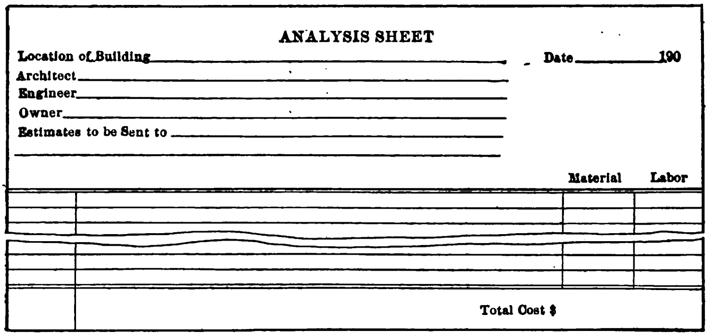
The system described can be broadened or cut down to meet requirements. The owner may be his own superintendent and foreman, as well as do his own estimating and draughting. The bookkeeper can do all the bookkeeping and collecting, etc.

A system of this kind will be found very valuable and is inexpensive. It must be kept up to be of value, as partial records of costs and other details are worse than none. Oftentimes in an endeavor to improve matters, too theoretical a view is taken, leading to the employment of elaborate and complicated forms. Records should be as few and simple as possible. A good system is additionally valuable, as it does not make a "one-man business" out of a concern. A new man, by consulting the records should be able to grasp his duties, as well as the swing of the business, at once.

CHAPTER II.

ESTIMATING ON CONTRACT WORK.

THE problem of estimating is simply one of analysis. When figuring on the cost of wiring a building according to a set of plans and specifications, the contractor should first carefully read the specifications to ascertain if they


ANALYSIS SHEET

Location of Building ________ Date ________ 190

Architect ________

Engineer ________

Owner ________

Estimates to be Sent to ________

Material Labor

Total Cost $

FIG. 18. — Actual size, 8 inches wide by 12 inches high.

contain any unusual requirements. In reading the specifications the contractor should note if he is expected to do cutting and plastering, and also note if any scaffolding is required. These items increase the expense, and if not counted lessen the profit.

The specifications for the wiring of a building are usually divided into the following clauses:

General Conditions.
System of Wiring.
Mains and Feeders.
Panel Boards.
Circuit Wiring.
Special Devices.

If the plans and specifications give the complete data, such as the size of feeders and the location of panels, the contractor has only to write down the details on an analysis sheet (Fig. 18) and add the cost of labor. Where the complete data are not given, it is necessary for the contractor to lay out the wiring systems and take the data from these.

In making up an analysis sheet when estimating for wiring a building for electric lamps, using a conduit system, all items coming under the head of panels, such as meter boards, service boards, panels, switches, distributing boxes, etc., are written down first. If the contractor has sufficient time, a list of these should be made up and sent to two or three manufacturers for quotations. If the panels called for are standard, the last price of similar goods should be used.

The length of run of the mains and feeders is then measured and recorded, together with the quantity of wire and conduit required; the labor is also estimated. The circuits are next measured, and the length of pipe and wire required written down; also fittings, such as elbows, couplings, lock nuts and bushings. By adding 10 per cent to the cost of the pipe, the fitting item is usually provided for. The number of outlet boxes, switch boxes, switches, receptacles, etc., and the labor for installing them are then added, together with a sum for sundries, such as cartage, car fares, inspection fees, etc.

An estimate should always be on the safe side. If better cost prices are obtained later, these often offset unforeseen contingencies. In figuring the labor cost, the contractor must be guided by past experience and data from the cost book. The cost for installing conduits is usually quoted at so much per thousand feet; molding, at so much per hundred feet; cleats, at so much per hundred pair, and so on.

When making a quotation, the contractor must take into consideration the amount of competition. If possible he should find out who his competitors are and how they have bid on similar work. A good plan is to add to the cost of the material a certain percentage of profit. This

percentage may be smaller than the percentage added to the labor cost, inasmuch as the material can be accurately estimated, whereas labor is always an uncertain item, and the percentage added should be larger to compensate for the risk.

In making estimates care must be taken to learn the character of the construction of the building. When estimating on work for a finished house it makes quite a difference whether the building is furred or not. If furred, the wires are easily "fished"; if not, floors must be taken up and the beams bored. The cost of labor is naturally double in buildings not furred.

In figuring on a molding job, the fact that the ceiling is of lath and plaster, and therefore requires the molding to be fastened with screws, makes the cost of labor greater than if the ceiling were such that nails could be used. In close competition, these minor points favor profits.

In estimating without plans, as is the case when one is asked to look over a building, the best plan is to figure per outlet. For example, on an open-work iron pipe job, experience and reference to the cost book will indicate that the cost per outlet is, say, $3.50. To this must be added the cost of feeders and panels. These latter may be put down at $20 erected, and feeders, if of average size, at 35 cents per foot. In figuring on drop lamps, a certain percentage should be added for the cost per drop. On molding or cleat work, the procedure is the same. Where the job is large and warrants the drawing of a plan, this should be done and an analysis made in order to check the prices per unit.

Another way of estimating is to figure the number of lamps, and, if fairly distributed, average them ten to a circuit. If the building is of average size, it is safe to assume each circuit to be 75 feet long. This will give approximately the number of circuit feet. The rest of the details, such as feeders, panels, etc., can be easily approximated.

When estimating on very large jobs a circuit-detail

analysis sheet, such as is shown in Fig. 19, is often used. The total on this sheet is carried over to the general analysis sheet. These analysis sheets should be carefully filed in a special cabinet. All amendments or changes in the plan should be filed with the original. If a contract is obtained, the analysis sheet should be used by the foreman as a basis on which to order material. The sheet should also be compared with the cost books when the work is completed. By this means much valuable information is

CIRCUIT ANALYSIS

Location of Building ______________________ Date ____________ 190

Architect ______________________

Engineer ______________________

Owner ______________________

Estimate Transferred to General Analysis Sheet No. ____________

Floor	Circuit	Outlets		Switches	Recept-acles	Floor Recept-acles	Feet of Pipe	Feet of Wire	Fittings		
		Side	Ceiling						Elbows	Couplings	Lock Nuts and Bushings
Total											

FIG. 19. — Actual size 18 inches wide by 12 inches high.

often obtained. If the job was unprofitable through fault in estimating or through uneconomical management, reference to similar jobs and an analysis of details should indicate where the fault lies.

Estimating on large buildings should be no more difficult than estimating on small buildings; if large jobs are treated as a group of small jobs, the problem becomes quite simple. The cost of labor is naturally perplexing; yet there is no reason why on a straight job in a new building the time should not be practically the same in all cases. A man and a helper should put up so many feet of pipe or molding, as the case may be, in a day, and it is the foreman's duty to get at least that much work out of them. By revising the cost system as new conditions arise, the cost per unit of labor may be made a fairly certain item.

In measuring the number of circuit feet on a plan, a rotometer will save time and promote accuracy. An instrument of this kind made by Kolesch & Co., of New York City, is shown in Fig. 20. The little wheel is caused to run along the circuit lines and the dial registers in feet and inches. If the drawings are made to a scale of $\frac{1}{4}$ inch to the foot, the reading is multiplied by 4 to obtain the circuit feet. As these measurements do not provide for the side-wall runs to side outlets and switches it is necessary to add a certain number of feet to provide for these. A good plan is to total the number of side outlets, switches, and receptacles, also the number of circuits for runs to panels, and multiply this total by 10 if the ceilings are of medium height. This will provide for runs down to outlet and back to ceiling for a run to another outlet or switch. By the use of the rotometer the number of circuit feet of a large plan can be ascertained in a very short time.

FIG. 20.— The Rotometer.

CHAPTER III.

WIRING SYSTEM.

Before laying out the wiring system for a building, it is necessary to ascertain whether power will be supplied from the central station, or whether it is the intention of the owners to install a private plant to generate electric power.

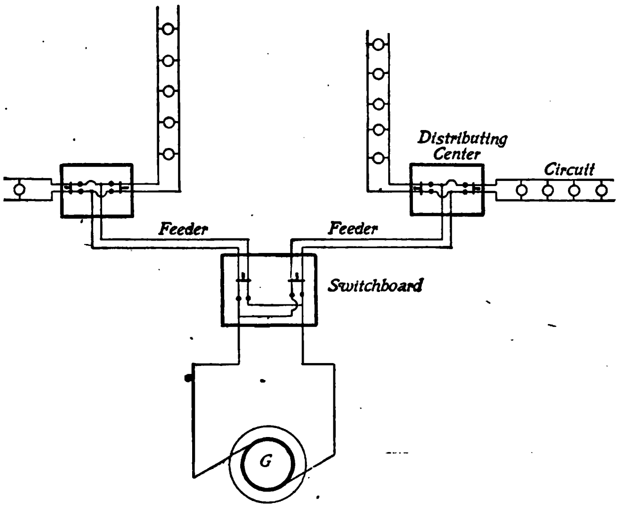


Fig. 21. — Two-wire system.

If the latter plan is decided on, a two-wire multiple system should be installed. Fig. 21 shows the general scheme of such a system in connection with a dynamo.

Should the local illuminating company supply power as an auxiliary or breakdown service, as it is called, this supply should be connected to the wiring system through a double-throw switch. This double-throw switch can

also be used as the generator switch and the method of connection is shown in Fig. 22.

Should the auxiliary supply furnished by the local illuminating company be brought in through a three-wire system, the connection at the switchboard would be made

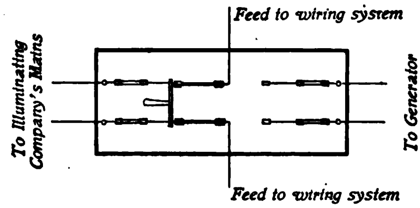


FIG. 22. — Arrangement for connecting to public or private mains.

through a double-throw, three-pole switch, as shown in Fig. 23.

Should it be decided to use only the power from the local electric-service company, the system in use must be ascertained before the general scheme of wiring is laid out.

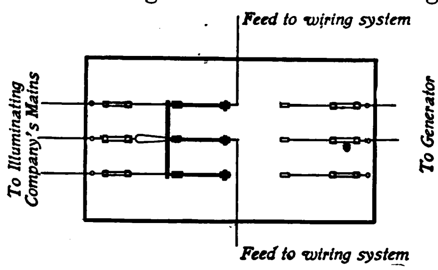


FIG. 23. — Arrangement for connecting to three-wire public service or two-wire private service.

If a three-wire system is used, the general scheme of wiring will be as shown in Fig. 24. When installing this system in a building it is best to put in the three-wire convertible system, or "three-wire two-wire," as it is sometimes called. The only difference between this system and the straight three-wire system is that the center, or neutral, wire of the mains and feeders should have a current capacity equal to

the other two. The reason for this is that it allows the system to be readily changed over to a two-wire system for use in connection with a private plant. It sometimes happens that after using power from the local company for some time, conditions arise which make it expedient for the owners to install a private electric generating plant. If a straight three-wire system had been originally installed, the mains and the feeders when used on a two-wire system

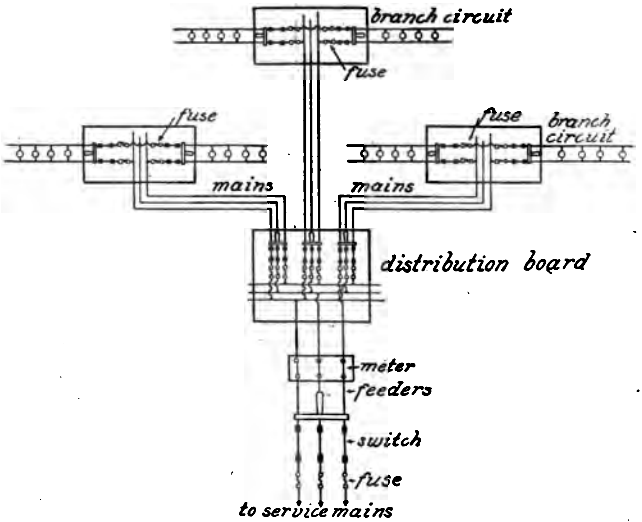


FIG. 24. — Three-wire system.

would not be heavy enough by 25 per cent, as the neutral wire of a straight three-wire system is the same in size as one of the two outer wires, and theoretically carries one-half the current or less.

To change a regular three-wire system to a two-wire system would be expensive, since it would require the reinforcement of all mains and feeders by an additional wire. This wire would be connected with the neutral wire so as to make the capacity of the neutral equal to the

sum of the other two (Fig. 25). On the other hand, if a three-wire two-wire system had been originally installed, no change in the wiring system would be necessary. The only change would be at the service end of the switchboard

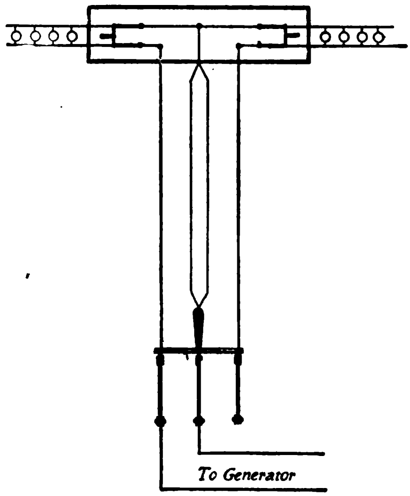


Fig. 25. — Connection for switching from three-wire to two-wire system.

(see Fig. 26) and the doubling of the size of the center fuses. It is, of course, possible to install a plant to operate a three-wire system, but such a plant is more expensive to

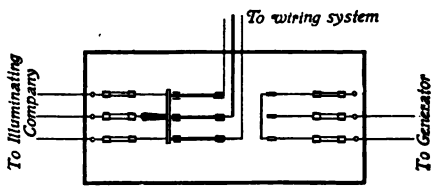


Fig. 26. — Method of changing from three-wire to two-wire system.

install than one for a two-wire system, as it is necessary to add a balancer in connection with a 240-volt generator. This balancer set should have one-tenth the capacity of the plant. Such an equipment has its advantages when

240-volt motors and 120-volt lamps are connected to the system. With this plant no changes in the motors are necessary, whereas in a straight 120-volt system the motors would have to be changed from 240- to 120-volt machines.

The supply from the local illuminating company may be two-phase alternating, and if the load to be connected to such a system is small, say not over 10 kilowatts, the general practice is to wire for a straight two-wire system, using one phase of the current for a supply. In larger installations power is taken from both phases and balanced the same as a three-wire system. A four-wire main, or

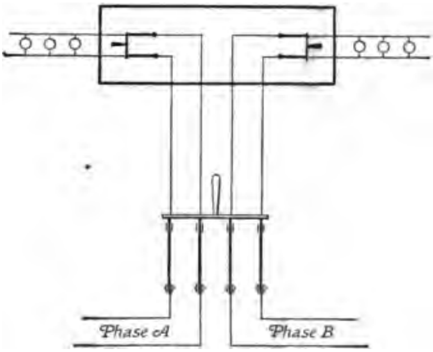


FIG. 27. — Four-wire two-phase feeder system.

feeder system, can be used (see Fig. 27), in which each set of two wires carries one-half the current, or three wires can be used, as in a three-wire system. The difference between the two is that in a three-wire, two-phase system the central wire should have 1.8 times the capacity of one of the outside wires. It should be always borne in mind that if any alternating system is used in connection with iron pipe or conduit, all the wires of a circuit must be placed in one pipe to avoid induction. In a two-phase system the two wires of each phase can be placed in a pipe. This matter is fully covered in the Underwriters' Electric Code.

As soon as a decision is reached as to the particular

system to be used, the contractor may lay out the mains, feeders, and branches of the wiring system. The outlets are first located and then the distributing centers. There is no fixed rule or plan by which to go, but the current density and source of supply are the main points to be considered in locating these centers. Another point which must be taken into consideration is the construction of the building with relation to runways and shafts, which provide easy runs for feeders.

In Fig. 28 is shown a floor plan of a loft building, in which the outlets are distributed evenly. The source of supply is in the front of the building, and an elevator shaft is located near by. This shaft is an ideal place for placing the feeders, and the panel is shown near the shaft. In

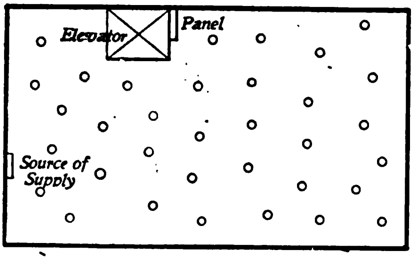


FIG. 28. — Even distribution of outlets in a floor plan.

many buildings it is impossible to run the feeders up the shaft, owing to the construction of the same. In such cases the feeders are run up the side walls, or in specially-built pipe shafts. Feeders and panels should be located at current centers.

Panel boards in loft buildings, or in any building requiring from 8 to 10 circuits per floor, should be distributed one for each floor. In private houses it is sometimes advisable to install only one panel for the entire house. This is good practice for a three-story house not requiring over twelve circuits.

In a building covering a large area it is often advisable

to install two panels or centers per floor, with two sets of feeders. It is advisable to keep circuit lengths down to 100 feet or less; the judicious laying out of circuit centers will save many feet of wiring.

The feeder system for a building depends on many conditions. A good scheme is to draw an elevation of the building (Fig. 29), and note on each floor the current requirements. The best plan is to furnish a feeder for every floor, especially in large installations. In smaller installations one or two feeders are sometimes all that are required. Feeders for motors should be installed independent of the lighting feeders. In the case shown by Fig. 29 it will be seen that the basement and first floors require the most power. In such a case a feeder is run for these floors, and a sub-feeder from the basement to the first floor. It is not worth while to reduce the size of the sub-feeder unless the amount of current in the sub-feeder is a small percentage of that in the feeder. Another reason is that in changing the size of a wire the underwriters require a fuse to be inserted. This makes it necessary to install a larger panel with larger trim, etc., and the consequent expense easily offsets any gain made by installing a smaller wire.

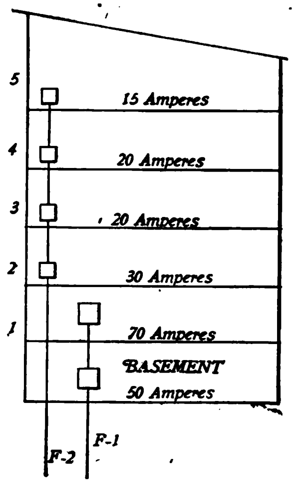


FIG. 29. — Feeder system for a building.

Feeders requiring over two-inch pipe should not be used. It is better to subdivide them, especially if there are many bends or offsets, since two-inch pipe is about the limiting size for economical handling.

The feeders should all radiate from a distributing panel, having a proper sized switch and fuse for each feeder. If the system of wiring is such that auxiliary power is taken from a local company it is a good plan to have each circuit

controlled by a double-throw switch so that in case of overload any circuit can be fed from the company's mains (see Fig. 30).

The main wires should start from the public service company's service, and these companies have their own requirements as to where the contractor is to wire from. Some companies make the contractor run a line outdoors, furnish switch and fuse and also meter-board and loop. Other companies do not. The contractor can easily ascertain the requirements by consulting the local inspector.

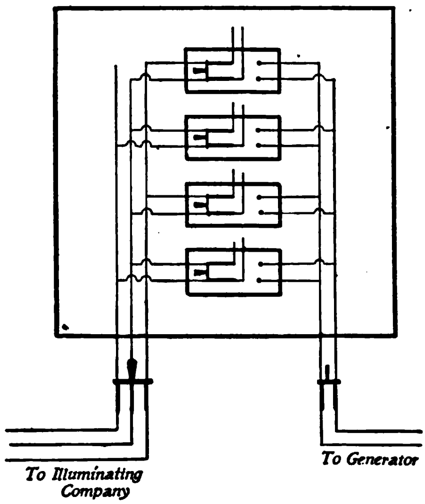


FIG. 30. — Method of controlling each circuit by a double-throw switch.

The mains should be carefully installed and be of ample size. The contractor should urge his customer to provide for at least 25 per cent more current than is at present required; and if future requirements are known, in a general way, the wiring for the ultimate load should be installed although the immediate requirements call for a much smaller wire.

The contractor benefits by this surplus, and can more readily obtain orders for additions which would perhaps

not be considered if the mains had to be changed at considerable expense.

It is a good plan to run mains and feeders in iron pipe even though the circuit wiring is run otherwise. Since the former carry the main supply of current it is important to have them well protected, as they usually run up side walls. The Board of Fire Underwriters make numerous restrictions against open or molding work on brick walls, and require good protection, and this is an additional reason for piping the mains and feeders.

In laying out the branch circuit wiring, it is not a wise plan to use up the Underwriters' circuit allowance of 660 watts. Of course it will cost a little more to run ten 16-candlepower lamps or 500 watts to a circuit, but it is good practice. There are always small additional loads thrown on the wiring system, and if the circuit capacity is not up to the limit additional outlets may be cheaply installed. From a business standpoint this plan has two sides. One is that the contractor can earn more by installing an extra circuit, while on the other hand the additional expense of running the circuit will often deter a customer from making any changes.

In circuit runs over 100 feet long on a 110-volt system, No. 12 B. & S. gauge wire should be used, otherwise the drop of voltage will be too large. When locating side-wall brackets in adjoining rooms these should be placed so that they will come back to back (Fig. 31). This saves much wiring.

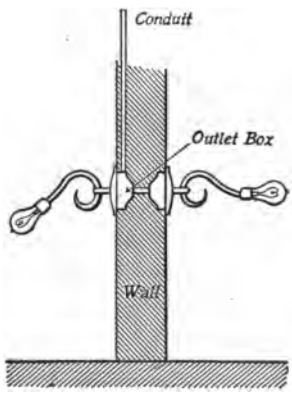


FIG. 31. — Side-wall bracket in adjoining room.

In laying out a system of wiring, using molding or knob and cleat work, the scheme of panels and feeders is the same. The difference is in the wiring appliances, which will be treated in subsequent chapters.

In calculating the size of conductors, the following wiring formulas will be found sufficiently accurate for general purposes:

For Two- or Three-wire, Direct-Current Lines.

$$21.62\ lI \div e = A, \text{ in cir. mils,}$$

l being the distance in feet one way, I the current in amperes, and e the volts lost in the line.

Example.— Required, the size of mains to feed 100 16-candlepower incandescent lamps requiring 0.5 ampere each, the voltage of the circuit being 110, the distance 50 feet and the voltage drop 2 per cent.

$21.62 \times 50 \times 100 \times 0.5 \div (110 \times 0.02) = 24{,}523$ cir. mils = No. 6 B. & S. gauge wire, which is the nearest size.

In a 110-volt, three-wire system (220 volts between the outer wires) the current requirements should be calculated as equal to one-half that of a straight two-wire system. Consequently the three wires will each be one-half the size required on a two-wire system.

For Alternating-Current Lines.

$$lPK \div pE^2 = A, \text{ in cir. mils of each wire,}$$

l being the distance of transmission in feet one way, P the total number of watts to be transmitted, p the per cent loss in the line, E the voltage of the circuit, and K a constant, the various values for which are given in Table I.

TABLE I.

	Values of K.				
Power-factor	100	95	90	85	80
Single-phase	2160	2400	2660	3000	3380
2-phase (four-wire)	1080	1200	1330	1500	1690
3-phase (three-wire)	1080	1200	1330	1500	1690

Example.— What size of conductor will be required to transmit 100 amperes a distance of 50 feet on a two-phase system at a loss of 5 per cent, the voltage of the circuit being 110 and the power-factor 90?

$$100 \times 110 \times 50 \times 1330 \div (5 \times 110^2) = 12{,}091 \text{ cir. mils}$$
$$= \text{No. 8 B. \& S. wire, size of each wire.}$$

In all calculations for the size of wire the Underwriters' requirements must be adhered to, so that if the calculated size for certain conductors is smaller than that allowed by the Board of Fire Underwriters, the size of wire given in the Code must be used.

CHAPTER IV.

EXPOSED CIRCUIT WIRING.

THE various kinds of circuit wiring in which the wires are supported on porcelain insulation, and including exposed surface wiring, outside circuit wiring, concealed knob-and-tube work are the least expensive methods of wiring, and if properly and neatly installed make a very satisfactory job from the electrical standpoint.

Knob-and-tube work is extensively used for wiring houses of frame construction. The holes in the floor beams are drilled just a trifle smaller than the porcelain tube so that these can be tightly driven in without breaking. Porcelain tubes for this work have a shoulder on one end which butts against the beams. The holes are drilled with a long bit, resting against the top of the beam next to the one drilled; the holes are thus drilled at an angle, and the wires zig-zag when threaded through the tubes. In estimating, 10 per cent additional wire must be allowed for

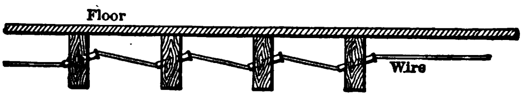


FIG. 32. — "Zig-zag" wiring.

the additional length of wire required for the "zig-zagging." (See Fig. 32.) Do not run the two-circuit wires closer together than 6 inches. Where the wires are brought out for outlets, cover them with flexible or porcelain tubing, especially where they pass through the plaster walls or ceiling.

Rubber-covered wire must always be used in this class of work. Where wires cross each other, cover one with

a porcelain tube, which should be fastened with tape or cleated down to prevent the tube slipping out of place. Joints must, of course, be very carefully made and soldered, so as to prevent loosening up and arcing. Then a layer of pure rubber tape should be put over the joint as well as two layers of friction tape, the latter then being thoroughly painted with moistureproof paint.

The feeders, or risers, as they are sometimes called, should be run on porcelain knobs fastened to the studding. Porcelain two-wire cleats should not be used for this purpose. A good type of insulator is shown in Fig. 33. The wire is clamped and held tight between the upper and lower section of the insulators. This method of fastening wires to insulators is better than using tie wires. The slight additional cost of the split insulators over the solid ones is more than compensated by the saving in labor and in tie wires where the omission of tie wires is allowed. If tie wires are used they must have insulation equal to that of the wire tied. It takes 8 inches of wire to properly tie a No. 14 wire to a standard 3-inch insulator. The wires must be supported at least every 4.5 feet, and if exposed to injury must have the porcelain supporters closer.

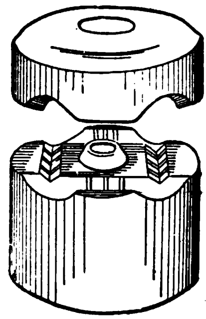


FIG. 33. — Porcelain knob.

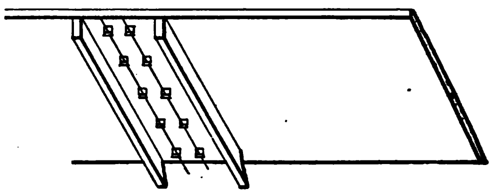


FIG. 34.—Wooden guards for protecting wires.

In unfinished attics, wires must be run the same as if concealed, and in no case should they be exposed by running on the upper side of beams. Wires running near water

tanks must be rubber covered, as the underwriters class them as exposed to moisture.

Wires run on ceilings of low basements, where they are liable to injury, must be protected by a wooden guard strip on each side. This strip should be $\frac{7}{8}$ inch thick and as high as the insulators or cleats. (See Fig. 34.) In this class of wiring, as well as in all others, no wires smaller than No. 14 B. & S. gauge should be used, and no more than 660 watts allowed to a circuit. All wires larger than No. 8 B. &. S. must be soldered into lugs where connections are made.

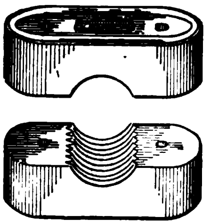


FIG. 35. — Single cleat.

Factories of open mill construction having wooden beams and girders are usually wired with conductors run on porcelain cleats and knobs. The mains, if No. 4 B. & S. size or larger, should be run on single cleats, as shown in Fig. 35. Although the rule is that the wire should be supported every 4.5 feet, exceptions are made on wires of No. 8 B. & S. gauge or larger. If the wires are not exposed to injury they can be run from beam to beam instead of breaking around.

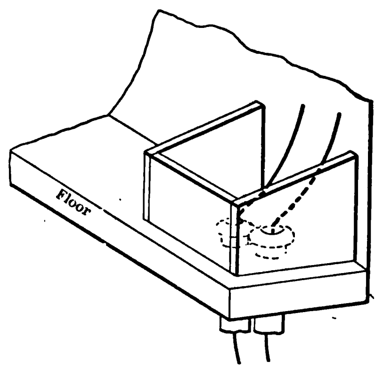


FIG. 36. — "Kicking block" protecting porcelain bushing.

If heavy wires are to be run through the beams a special form of brace will be found serviceable, by means of which holes can be easily drilled parallel with the floor instead of at an angle. This method of drilling saves labor as well as 10 per cent of wire, which, in heavy cables, is an item. It also avôids the difficulty of pulling heavy wires through tubes set at an angle in the beams.

Where wires pass through partitions or walls they must be protected by porcelain tubes. When they pass through

the floor they must have porcelain bushings, which must be protected by a "kicking block." (See Fig. 36.) They can also be passed through an iron pipe running 6 inches out on each side of the floor. In running the wires through the pipe they must be protected by flexible tubing. (See Fig. 37.)

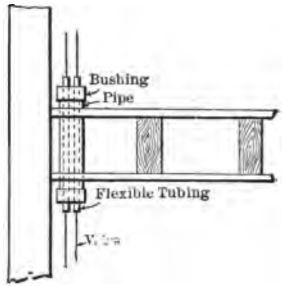


FIG. 37. — Wires protected by flexible tubing, running through iron pipe.

Always pass all wires of a circuit through one pipe, especially if the circuit is to carry alternating current, otherwise induction will cause trouble. The underwriters insist on this, even when direct current is used. They say that they cannot tell at what future time the alternating current may be substituted, and naturally then cause trouble.

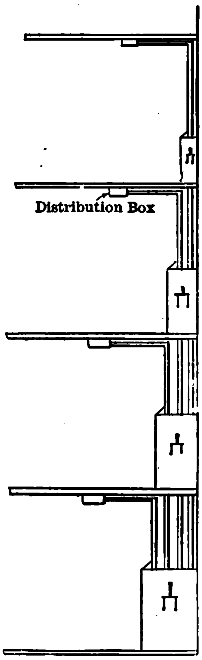


FIG. 38. — System of feeders for a 4-story factory system.

In installing feeders in buildings not subject to dampness it is best to place them on the walls. In dry buildings the fire and weatherproof wire can be used, otherwise rubber-covered wires must be installed, which adds considerably to the cost.

In running feeders on the walls they should be boarded in for at least 6 feet above the floor as a protection from injury. If a floor-switch is used it can be mounted on the front of the boxing. The holes through which the wires pass to the switch should be bushed with porcelain, or the wires should be covered with flexible tubing. An arrangement of feeders for a 4-story factory system is illustrated in Fig. 38.

The circuit wiring should be run on porcelain cleats, provided the building is dry. If exposed to dampness or acid

fumes the wires must be run on knobs and be rubber covered. Standard cleats are glazed, and in two pieces, with grooves 2.5 inches apart, to carry both wires. The wires must be supported at least every 4.5 feet. If the beams are further apart so that supports are over 4.5 feet apart, a running board must be run from beam to beam,

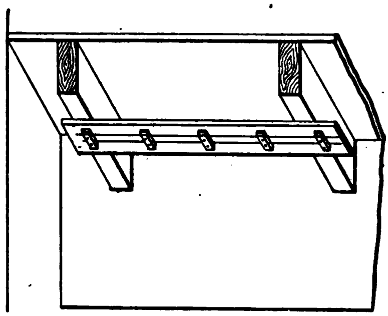


FIG. 39. — Wires running across beams on boards.

and the wires cleated on the board. (See Fig. 39.) It is a good plan to avoid this by running the circuit wires parallel with beams or girders so as to cut out the expense of the running board. This can usually be accomplished by

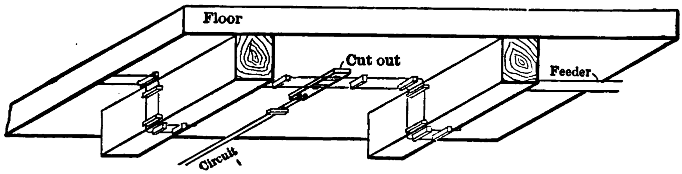


FIG. 40. — Circuit wires running parallel with beams and sub-feeders across the beams.

running a sub-feeder from beam to beam and feeding the circuits in this manner, as shown in Fig. 40.

On low ceilings or in lofts where cases are piled up, guard strips, shown in Fig. 34, must be provided.

In stables, breweries and all buildings subject to dampness and acid fumes, wires must be run on porcelain knobs,

not cleats, and must be rubber-covered. Feed wires running up side walls must be *boxed* in, or can be installed in iron conduits. *Moldings are never permitted* where dampness exists. All sockets and fittings for use in damp buildings must be specially made to withstand moisture.

Where wires cross damp pipes they should run over the pipes, not under, so that the moisture cannot drip on the wires. The wires should be covered with porcelain tubes where crossing pipes, to protect them in case they fall on the pipes. The tubes should be securely taped on the wires.

In wiring stores, offices, or buildings having flat ceilings, cleats should be used. This is the cheapest and quickest way to wire such places, and, where appearance does not count, is preferred for these reasons. Wires should have no kinks and must be stretched very tightly. In wiring circuits with cleats, a good plan on straight runs is to tighten both ends after stretching the wires, and then fill in with cleats at least every 4.5 feet.

When circuits are run out of doors great care must be used in properly insulating the wires. Only waterproof devices and rubber-covered wire should be used for such work. At the point where wires run out of a building it is a good plan to have a switch and cut-out. Run them out in iron tubes so bent as to form a drip loop. An iron elbow pointed downward and with bushings on the end makes a good fitting for this purpose.

In summer gardens and outdoor places of amusement open-circuit wiring is extensively used. Use only porcelain knobs, no cleats, for outdoor circuit wiring. All the fittings should be waterproof, and care must be used in the selection of sockets.

Strings of lamps are very frequently desired to light gardens, walks, etc. A good scheme for wiring up such a string is shown in Fig. 41. The strain is taken by a galvanized steel cable. To this the lamps are attached by means of iron hangers. The split insulators on the ends grip the circuit wire as well as the socket wire. Such a method of stringing wires is the best to use, though a little more

expensive than stringing them without the galvanized wire support. The circuit wires are pulled tight and fastened to the porcelain insulator as illustrated. Use insulated turnbuckles to keep the galvanized wire taut, which when slack can thus be readily tightened up.

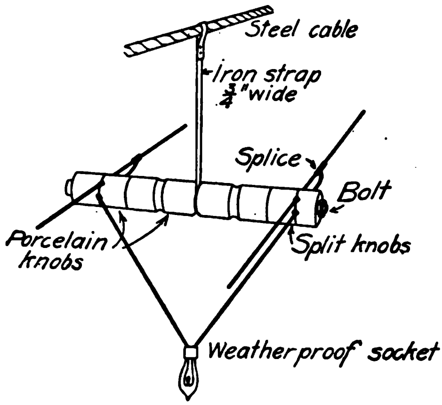


FIG. 41. — Methods of lighting gardens, walks, etc.

In factory work where there are a number of detached buildings supplied by a central plant, outside line work becomes a necessary branch of the wireman's trade. For such work triple-braided weatherproof wire should be used. Where wires enter and leave buildings, they should have suitable supports, and the insulated turnbuckles should be used to take the strain off the pins and insulators. (See Fig. 42.) Use a good quality of insulator, as illustrated, and screw it on an iron pin. Wooden pins break too easily, and for that reason should not be used.

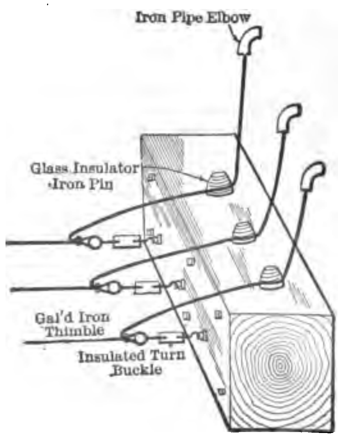


FIG. 42. — Support of wires leaving a building.

Lightning arresters should be installed on all outside feeders unless the runs are very short. Care must be used properly to install the lightning arresters, for if improperly installed they are dangerous. The ground wire should run to the ground in

a straight line, not having any angles or bends. If run through an iron pipe the wire should be soldered to the pipe or the arrester becomes useless.

Stranded wires should be used, and should be fastened securely to a copper ground plate, and then soldered. This plate should be buried in damp ground surrounded by pulverized coke, or charcoal. The ground plate should have at least two square feet of surface and be $\frac{1}{16}$ inch thick, Paint over with waterproof paint where the wires are soldered to the plate, to prevent corrosion.

In selecting fittings, such as rosettes, receptacles, etc., for use in connection with exposed wiring, the points to consider are prices, adaptability, appearances, and last but not least, whether they are National Electric Code standards — that is, are approved by the underwriters.

Snap switches for use in connection with exposed wiring should be mounted on small porcelain knobs, as shown in Fig. 43. This allows the wire to be brought through the back of the switch without coming in contact with the walls.

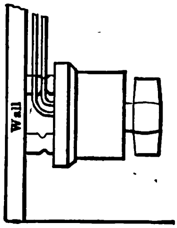
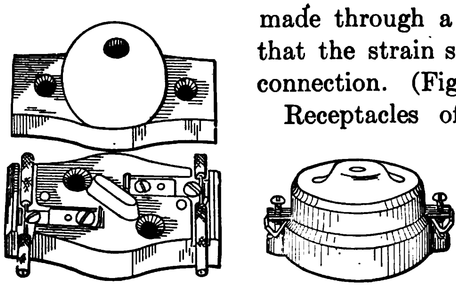


FIG. 43. — Snap switch mounted on porcelain knobs.

The commonest type of fixture is the drop lamp, in which the lamp socket is connected by means of flexible cord to the circuit wires. This connection is best made through a porcelain rosette, so that the strain shall not come on the connection. (Figs. 44 and 45.)



FIGS. 44 and 45. — Rosettes.

Receptacles of various types are used in connection with open wiring. Those herewith illustrated are suitable for the work. It is best to use those not having the exposed contact ears.

For use in connection with wiring in damp places or out of doors, weatherproof devices are necessary. For

weatherproof drop lamps use No. 14 B. & S. flexible rubber covered wire, which should be soldered directly on the circuit wires and to the leading wires on the socket, which should be weatherproof. (See Fig. 46.) Lamp cord should

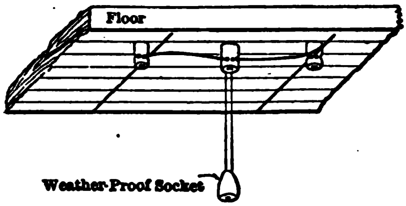
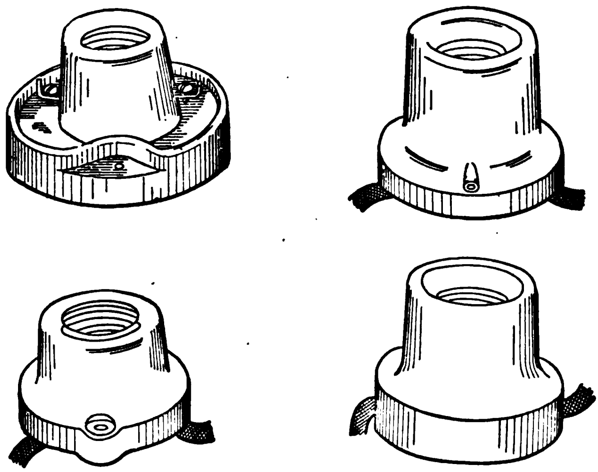


FIG. 46. — Wiring in damp places or out of doors.

never be used in damp places. A good receptacle for damp places is shown in Fig. 47. The base projects beyond the connecting plugs and a rim carries the drip away from the exposed contacts. Other forms of weatherproof recep-



FIGS. 47, 48, 49, 50. — Weatherproof receptacles.

tacles are furnished with wires already connected, as are shown in Figs. 48, 49 and 50. With these it is necessary to solder the wires to the circuit wires and mount them on knobs, unless the wires are brought through the sides as shown in Fig. 50.

CHAPTER V.

WIRING WITH WOODEN MOLDINGS.

WOODEN molding is extensively used by the electrical contractor in connection with commercial work in stores, offices, and factories. By its use it is possible to make an installation of neat appearance, provided the molding is run straight and is accurately mitered. Standard wooden moldings are made in sizes shown in full size and cross-section in Figs. 51 and 52, which also gives the size of wire each molding will take. The molding must have a suitable capping and must conform to the underwriters' specifications as given in Rule No. 50 of the National Electric Code. Wooden molding should never be used in damp places, or in buildings subject to fumes, such as stables, breweries, ice houses, etc.; nor should it be used on the inside of the outside walls of buildings, since these are subject to dampness. Wooden molding should never be concealed, and its use in air or elevator shafts is not permitted.

When buying wooden molding the purchaser should be careful to get only good straight stock, free from knots or other imperfections. The cost of labor required to handle second-class material and "work it in" makes this practice poor economy. A good type of molding is shown in Fig. 53. The grooves are circular and narrower at the opening than in the center. This form of groove holds the wire in place and enables the wireman to tack on the capping without the annoyance of the wire coming down. In the regular molding, shown in Fig. 54, it is necessary to hold the wire in place with brads.

When laying out a molding job, symmetrical designs should be followed so far as the distribution of the lighting permits. Where this is done the ceiling presents a neatly

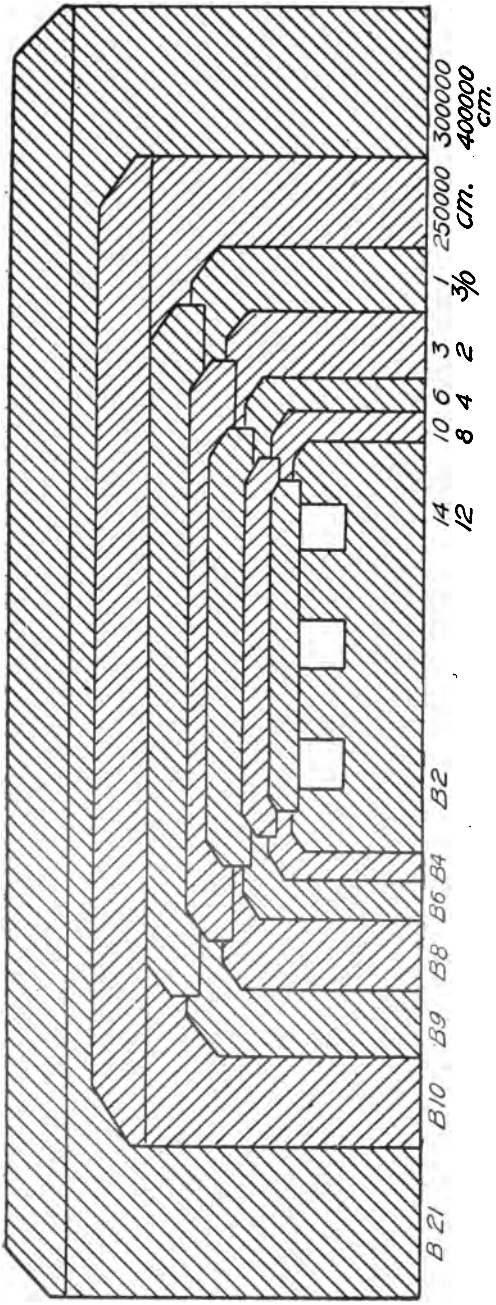


FIG. 51. — Cross-sections, exact size, Standard three-wire moldings.

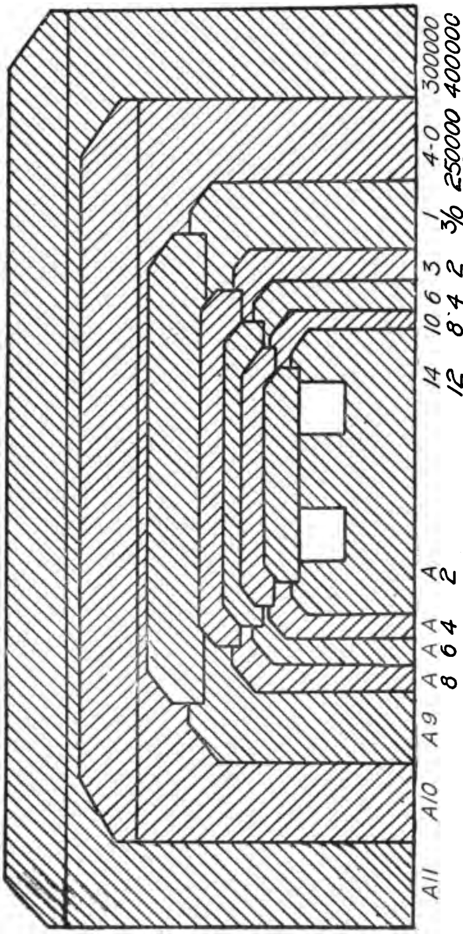
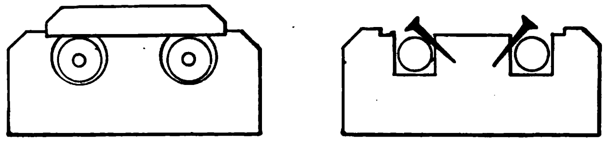


FIG. 52. — Exact sizes Standard two-wire molding.

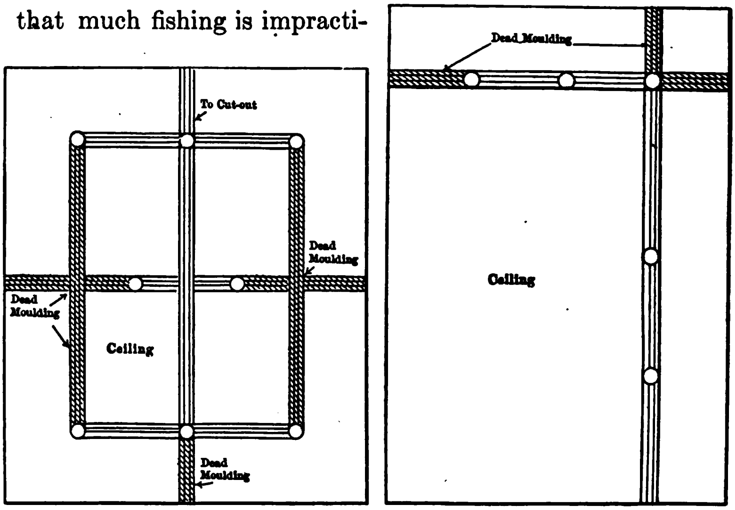
paneled appearance, as shown in Fig. 55. Molding runs should always be finished off. That is, if an outlet is run near one end of a ceiling, "dead" molding should be con-



FIGS. 53 and 54. — Types of molding.

tinued to the walls so as to give a finished appearance, as shown in Fig. 56.

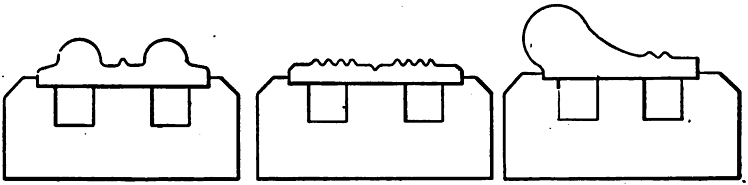
There are many cases where special moldings are necessary. This is especially true with private-house work, where conditions are such that much fishing is impracti-



FIGS. 55 and 56. — Molding layout. Molding.

cable and cutting is not permitted. The wood of such moldings should match the wood in the room, and the backing should be made to conform with the underwriters' specifications. The capping should match the trims or

resemble picture moldings. Various forms of special molding are shown in Figs. 57, 58 and 59. In Fig. 60 is shown a scheme for wiring a room for picture lighting.



FIGS. 57, 58, and 59. — Various forms of special molding.

The receptacles are stained to match the molding, which should harmonize with the other woodwork. If neatly done the wiring is concealed so far as appearance goes, and this is the object sought. The feeds are fished, as shown

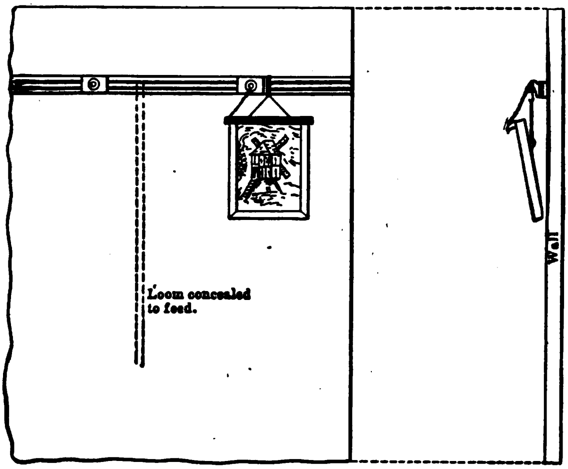


FIG. 60. — Wiring a room for picture lighting.

in the illustration, there being very few rooms in which it is not possible to fish the circuit feed wires. A "concealed molding" method of wiring bracket outlets is shown in

Fig. 61. It is, of course, desirable to fish the run from the molding to the bracket, as shown in the illustration; otherwise, the molding must be run to the bracket from the main line of molding around the room.

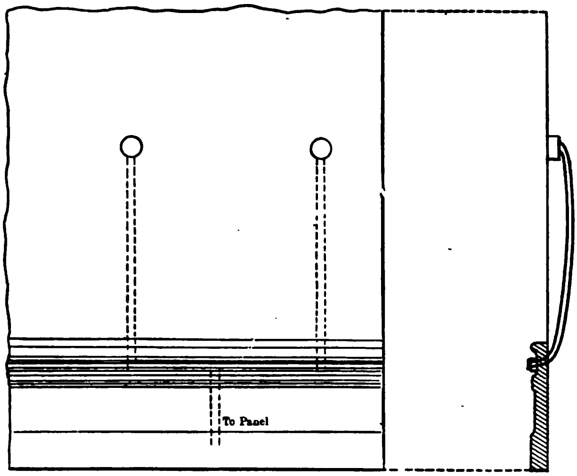


FIG. 61. — A "Concealed molding" method of wiring bracket outlets.

In combining concealed work with molding, fibrous flexible tube, such as "Circular Loom" or "Flexduct," should be used. In such a combination no splice box is necessary and single-braided rubber wire may be used throughout.

In some cases wooden moldings are permitted inside of outside brick walls which are exposed to the weather. In such cases a wooden backing one-half inch thick and painted with a moisture repellent should be first installed, and on this the molding may be fastened. Wooden molding must never be installed in shafts of any kind; iron pipe or flexible steel are the only materials permitted. In laying out the feeders for a molding job, it is often cheaper to use iron pipe in a shaft than to run moldings through the floors of the building. The cost of boring floors and bushing them offsets the additional cost of the pipe, while the contractor

is on the safe side and is in no danger of having an inspector compel him to take down the molding and put up a backing for the reason that the "wall might get damp."

Molding is often used in combination with conduit. When used in connection with solid pipe or flexible steel, an iron splice box is installed where the system of wiring changes. Fig. 62 shows a method of connecting a solid

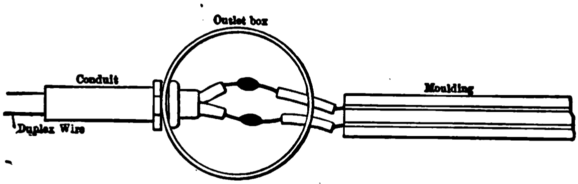


Fig. 62. — Method of connecting a conduit circuit to a molding circuit.

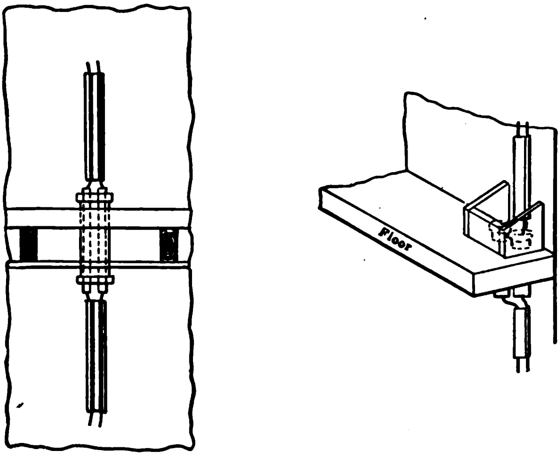
pipe circuit to a molding circuit. The loom should run up to the molding. The illustration shows uncovered wire with loom not drawn up tightly, so as to better distinguish the loom. A 4-inch outlet box with cover is used as a splice box, porcelain bushing or flexible tubes protecting the wires leading to the molding and bushings, and lock nuts being provided on the pipe. Fig. 63 illustrates a new

Fig. 63. — A Condulet fitting.

device which allows of a neat workmanlike connection to be made between a conduit and molding system. It is known as a condulet fitting.

When carrying wires from moldings through floors, porcelain tubes or iron pipe only should be used. This requirement is made by underwriters for the reason that water used in scrubbing floors will soak through fibrous tube and ground the circuits.

Figs. 64 and 65 show proper methods of carrying wires



FIGS. 64 and 65. — Methods of carrying wires through floors.

through floors. Where porcelain tubes are used a "kicking" block must be installed to protect the tubes from damage. The loom should be brought close to the molding, leaving no wire exposed. Illustrations demonstrate exposed wire showing the loom better. Fig. 66 shows a device made for the purpose, which can be obtained at any supply house. When iron pipe is used for the purpose of carrying wires through the floors, as shown in Fig. 65, a flexible tube should first surround the wires. A separate pipe should not be used for each wire, since if the current is alternating, induction will result, and the underwriters

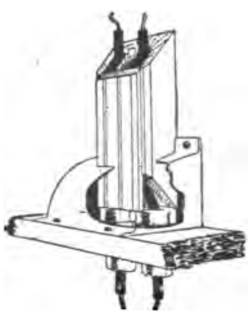


FIG. 66.—"Kicking block."

maintain that even though direct current may be used when the plant is first installed, alternating current may be substituted at a later period. When passing wires through walls or partitions, porcelain or fibrous tubes should be used.

In estimating on molding work, the nature of the surface to which the molding is to be fastened determines the labor cost. When fastening molding to lath and plaster, it is common practice to use long thin screws, and this is about 25 per cent more expensive than running molding over wooden surfaces. Fireproof walls or ceilings, especially those with a wire backing for the plaster, give the most difficulty in fastening moldings. In such cases it is necessary to drill holes which are then plugged with wood, to which the molding is screwed. The running of a hundred feet of molding in this manner constitutes a good day's work for a journeyman and his helper.

In running molding on arched ceilings having exposed I-beams, clamps are used to fasten the former to the latter, as shown in Fig. 67. In many of the modern fireproof

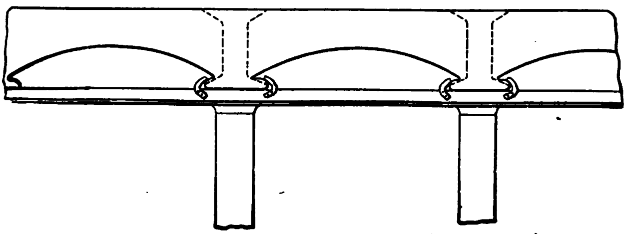


FIG. 67. — Molding running on arched ceiling fastened to I-beams.

buildings wired with conduit, the tenants often require a number of drop lamps. The circuits are taken from the ceiling outlets and the wires are run in molding. If the panel has no directory it will be necessary to make a diagram of the circuits and tap the outlets in such a manner that the 660-watt limit is not exceeded. When estimating on such work the contractor should ascertain the capacity

of the existing outlets, so that his estimate may be made to cover any additional circuit runs to the panel that may be required. When tapping the outlets for circuit feeders an iron outlet box with cover should be used. The wires in the unused outlets should be taped and caps or covers put over the boxes. Fig. 68 shows a method of tapping the

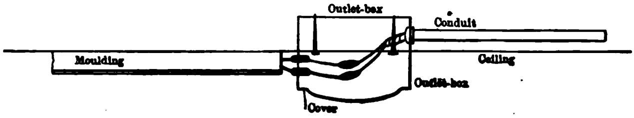


FIG. 68. — Method of tapping the outlet for molding work.

outlet for molding work, as described. Two long screws hold the one splice box up to the outlet box already installed. The loom should run close to the molding so as to leave no wire exposed. Fig. 69 shows the wiring scheme

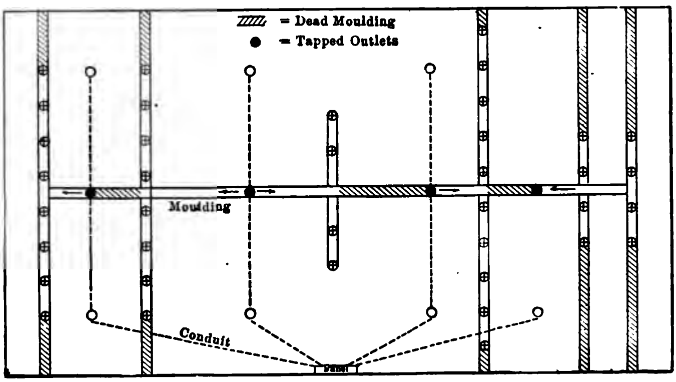


FIG. 69. — Wiring scheme of a fireproof ceiling.

of a fireproof ceiling, in which the existing outlets have been tapped and wire run in the molding as described. The "dead" portion of the molding is indicated by the shaded parts.

Molding wiring is frequently used in combination with flexible fibrous tubing, and for certain finished residence

and apartment-house work makes a good, cheap combination. Molding is used for the circuit feeds, the concealed runs to the outlets being made by wires tapped to the feeds and enclosed in fibrous tubing. As no splice boxes' are

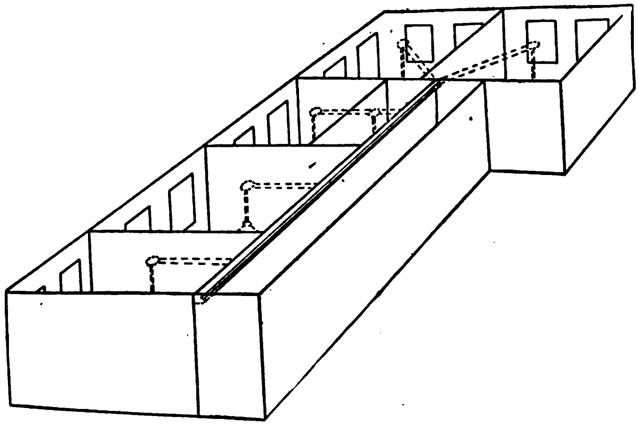


Fig. 70. — Wiring of an apartment.

required, this method is neat and cheap. Fig. 70 illustrates an apartment wired in this manner. If the ceilings are furred, an apartment of this kind should be wired in two days by a journeyman and helper, without breaking either walls or ceilings. The feeds are run up through the halls, and cut-out box and meter loop should be provided for each apartment.

Keyless receptacles set on moldings are used in wiring store windows, where the expense is to be a minimum. An aluminum reflector requiring no shade holder is used. Fig. 71 illustrates this combination. Molding cut to length, with receptacles and wires all in place, may be made up at the shop and installed in the store window in a short time. The reflectors should not be spaced more than 12 inches, and if dark goods are shown or if the window is deep or high, not more than 6 or 8 inches. If the frame of the window is not wide enough properly to conceal the lamps a curtain should be used; or, better still, a dark strip about 8 inches wide

may be painted on the window at the top. This strip may also be used as a transparent sign. This method of

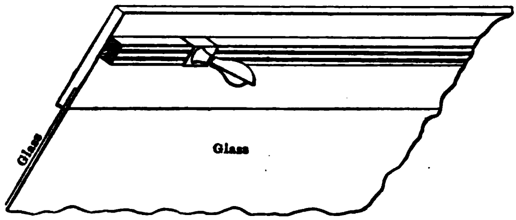


FIG. 71. — Keyless receptacles set on molding.

window lighting gives as good results as can be obtained by the use of mirror-trough reflectors and has the advantages of cheapness and quick installation. Mirror troughs must be made to fit the window, and if run on the sides a template of the miter at the angle must be sent to the manufacturer. All of this, of course, requires time and involves the risk of making mistakes in measurement and of breakage in transit.

Rubber-covered wire only should be used in molding. Single-braided wire is used in this work. When changing from molding to conduit, double-braided, rubber-covered wire must be spliced to the single-braided wire for pulling in the conduit. Where fixture outlets are installed, a circular fixture block 4 or 5 inches in diameter should be used. This not only gives a good support for the fixture,

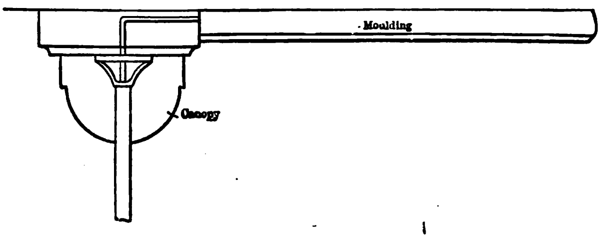
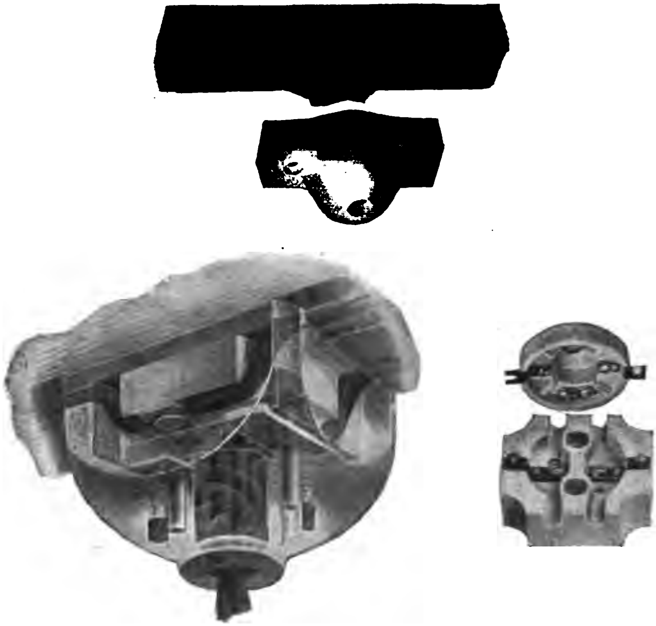


FIG. 72. — Methods of changing molding to conduit.

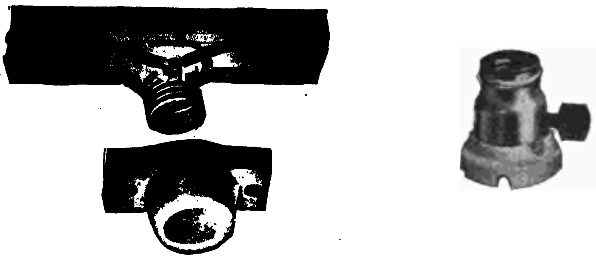
but also makes a neat backing for the fixture canopy. The wires are brought through the fixture block, as shown in Fig. 72; otherwise, it would be necessary to cut the

canopy and thus disfigure it. Porcelain rosettes for use in connection with drop lamps are shown in Figs. 73, 74



Figs. 73, 74 and 75.—Porcelain rosettes for use in connection with drop lamps.

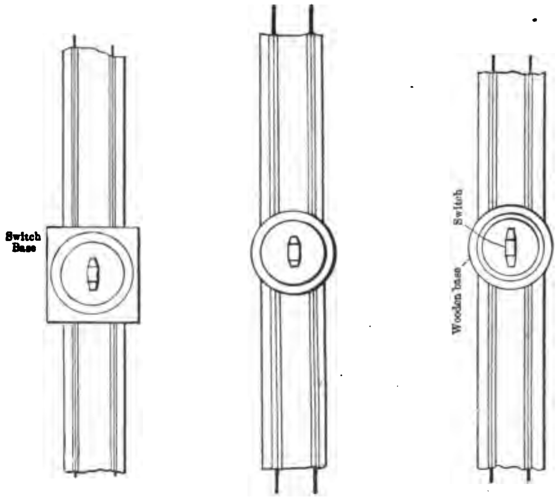
and 75. The rosette shown in Fig. 75 can be used either with or without fuses. Those shown in Figs. 73 and 74 are



Figs. 76 and 77.— Receptacles used for molding work.

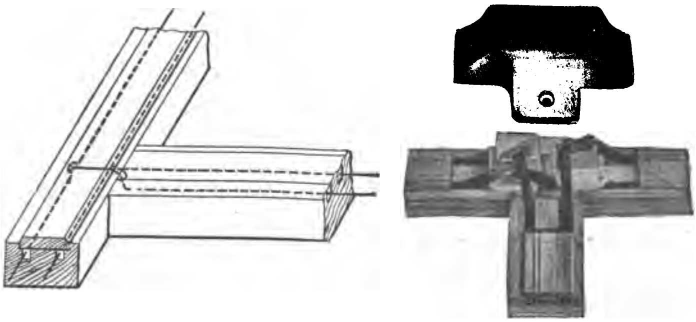
preferable for regular work, since they can be mounted directly on the molding and at the same time are much

neater in appearance. The receptacles shown in Figs. 76 and 77 are used for molding work. The former is preferable, since it may be installed much more quickly. When



FIGS. 78, 79 and 80. — Installation of snap switches.

installing the receptacle shown in Fig 77, care must be taken that this is not placed in a position where it is liable to be injured; otherwise, it must be protected by a box.



FIGS. 81 and 82. — Method of branching off in molding work.

The snap switches used in molding work should be mounted on a porcelain back, as shown in Fig. 78. By

using such a back the wires are easily and neatly brought through the switch. Snap switches should not be installed as shown in Fig. 79, that is, directly on the molding with no back; and if no porcelain backs are at hand the switch should be mounted on a round grooved block, as shown in Fig. 80.

In branching off in molding work, the tap is made as shown in Fig. 81. A good fitting for tapping circuits is furnished by the porcelain device shown in Fig. 82, by means of which time spent in splicing and soldering may be saved. It is almost needless to remark that if good work is to be done the workmen should be provided with proper tools, including a good saw and miter box.

CHAPTER VI.

WIRING WITH FLEXIBLE CONDUIT AND ARMORED CABLE.

THERE are two kinds of flexible conduit — fibrous and metallic. Two popular makes of fibrous conduit on the market are known by the trade names "Circular Loom" and "Flexduct," and are illustrated by Figs. 83 and 84 respectively. Both of these fibrous conduits possess the same general characteristics; both are approved by the National Board of Fire Underwriters, and both conform to the following data:

TABLE II.

Inside Diameter.	Outside Diameter.	Feet per Coil.	Largest Size of Wire Taken for Easy Pulling.
$\frac{1}{4}$	$\frac{17}{32}$	250	No. 14 B. & S.
$\frac{3}{8}$	$\frac{5}{8}$	250	No. 12 B. & S.
$\frac{1}{2}$	$\frac{3}{4}$	200	No. 8 B. & S.
$\frac{5}{8}$	$\frac{7}{8}$	200	No. 4 B. & S.
$\frac{3}{4}$	$1\frac{1}{16}$	150	No. 2 B. & S.
1	$1\frac{3}{8}$	100	No. 00 B. & S.
$1\frac{1}{4}$	$1\frac{11}{16}$	100	200,000 c.m.
$1\frac{1}{2}$	$2\frac{1}{16}$	...	400,000 c.m.
$1\frac{3}{4}$	$2\frac{1}{2}$	...	600,000 c.m.
2	$2\frac{3}{4}$	...	800,000 c.m.
$2\frac{1}{4}$	3	...	1,100,000 c.m.
$2\frac{1}{2}$	$3\frac{1}{4}$	...	1,300,000 c.m.

In addition to being used for complete wiring installations, this type of flexible conduit is also very largely used in connection with molding and exposed wire work as described in previous chapters. Fibrous conduit must not, however, be used in damp places or in fireproof buildings. Its particular field is finished frame buildings, where it can be easily fished from outlet to outlet. Fibrous conduit

having an internal diameter less than $\frac{5}{8}$ inch will not pass inspection, and when installing fibrous conduit it is best not to draw in the wires until the building is finished, so that any nails driven through the conduit will be located when the wires are being pulled in. On the other hand, if the wires were pulled in prior to the completion of the building, any nails piercing the conduit might easily cause trouble, if not actual damage. Duplex wires must not be used in fibrous conduit; single-braid, rubber-covered wire should be installed instead, double-braid wire not being required by the rules.

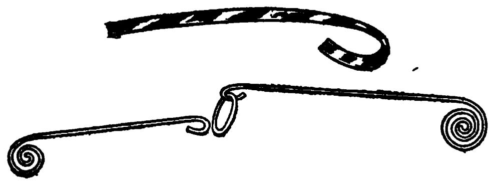
FIG. 83.—"Circular loom."

The "fishing" of conduits in finished houses constitutes one of the most difficult tasks of a wireman. The journeyman must be a good carpenter and mechanic as well as wireman to do a neat job. He must understand the construction of partitions, floors, casings, etc., and be an expert at taking up pockets. Where hardwood floors are encountered the taking up of pockets is rather difficult, since these must be relaid so as to make the opening inconspicuous.

FIG. 84.—"Flexduct."

A steel tape about 0.25 inch wide and 50 feet long known as a "snake" is employed for "fishing," the ends being heated and turned over as shown in Fig. 85. It is oftentimes necessary to fish from two pockets so as to engage the end of one snake in the end of the other. A

loop of twine is fastened to the end of one snake and the turned-in end of the other snake is opened slightly. The snakes are then worked toward each other and turned about



FIGS. 85 and 86. — "Steel Snake" employed for "fishing" conduit.

until the ends engage, as indicated by Fig. 86, when one is pulled through from outlet to outlet and the tubing fastened to it for pulling in. For vertical fishing a chain is employed. This is fed in at the outlet until it reaches the floor, the sound made by it in striking the floor serving to indicate where the pocket should be taken up and the chain pulled through.

Sliding door recesses are frequently used to bring circuits in. The doors may be taken out so as to give the wireman plenty of room, and the conduit should be well secured so as not to interfere with the sliding of the door. It is also well to locate switches at sliding doors for this reason. Iron outlet and switch boxes should be used in connection with fibrous conduit. It is not necessary to have the cut-out boxes lined with iron; asbestos will answer as well.

Flexible metallic conduit is known to the trade as "Greenfield" conduit, and is made in the following sizes:

TABLE III.

Outside Diameter, Inches.	Inside Diameter, Inches.	Feet per Coil.	Largest Wire Accommodated.		
			1 Wire.	2 Wire.	3 Wire.
$\frac{5}{16}$	.5	200	...	...	...
$\frac{3}{8}$	.6	200	...	...	...
$\frac{1}{2}$	.95	100	8	12	...
$\frac{3}{4}$	1.25	50	2	10	12
1	1.50	50	00	6	8
$1\frac{1}{4}$	1.75	50	200,000 c.m.	3	5
$1\frac{1}{2}$	2.05	50	400,000 c.m.	1	3
2	2.55	50	800,000 c.m.	200,000 c.m.	00

Greenfield conduit may be used on any kind of installation, and for many purposes it is far superior to rigid conduit. Though the first cost of the former is somewhat higher than that of the latter, when all conditions are taken into account it will be found to be cheaper. This type of conduit does not require the cutting of threads or fitting of elbows, and can be easily and quickly installed. Since the conduit is made in long lengths, few couplings are necessary. The writer does not look with favor on flexible conduit for new fireproof buildings; but for all other classes of buildings where a conduit job is wanted, flexible conduit is not only cheaper to install, but also makes a good installation. In order to dispose of short ends which quickly become scrap, one of these should be coupled to a new coil. Fig. 87 shows a coupling suitable for this purpose as well as for joining coils of conduit.

FIG. 87. — Coupling for flexible metallic conduit.

To cut Greenfield conduit a fine hacksaw should be employed, and in making a turn or elbow the conduit should be fastened in three places, or a special fitting, shown by Fig. 88, may be used for this purpose. It is needless to say that all conduit should be securely and rigidly fastened. The same rule about pulling in wires after the building is completed applies to Greenfield conduit as to the fibrous conduit. An approved form of outlet bushing for Greenfield conduit is shown in Fig. 89.

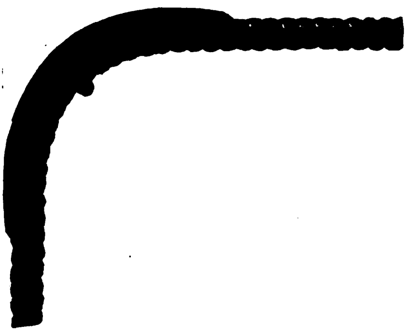


FIG. 88. — Elbow clamp for flexible metallic conduit.

Double-braid, rubber-covered wire must be used in flexible metallic conduit, and no conduit smaller than 0.5-

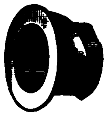


Fig. 89.— Bushing for flexible metallic conduit.

Fig. 90. — Straightaway junction box for flexible metallic conduit.

inch internal diameter will be passed by the underwriters. At all outlets, iron outlet boxes or switch boxes must be installed, and the conduit must be securely fastened to the

Fig. 91. — Outlet box.

Fig. 92. — Flush switch box.

boxes and must be provided with proper bushings. Figs. 90, 91, 92 and 93 show a number of iron outlet boxes suitable for this purpose.

Conduit should not be employed in places subject to dampness, unless the conductors are lead covered. Flexible metallic conduit is less liable to give trouble through

FIG. 93. — Split clamp switch box.

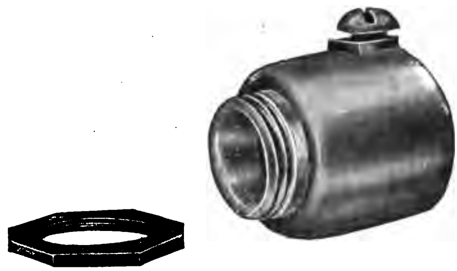


FIG. 94. — Lock nut and bushing for iron-lined panel boxes.

accumulated moisture than rigid conduit, since it is ventilated over its entire length. The writer has seen many short-circuits in rigid conduit due to accumulated moisture. Greenfield conduit should be properly grounded as required by the Code. At iron-lined panel boxes the use of a bushing, shown by Fig. 94, in connection with a locknut makes a connection of this kind easy.

A good system of wiring may be installed by employing flexible steel-armored cable. Fig. 95 illustrates a steel-

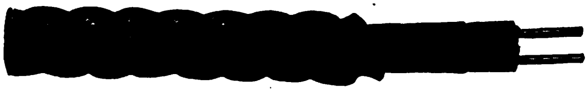


FIG. 95. — Twin conductor armored cable.

armored cable known to the trade as BX. This cable is made with conductors of No. 6 B. & S. gauge to No. 14, and since the greatest field for this cable is for circuit wiring, No. 14 is the size most frequently used. Where the runs are over 100 feet, No. 12 cable should be used. Steel-armored conductors are cheaper to install than fibrous tubing, and make a much more satisfactory job. The saving in labor over that required to install fibrous tubing

is considerable, and for finished private-house work there is nothing superior, since the conductors are easily fished. BX cable is made by winding a sheet-steel sheathing around a pair of specially insulated conductors.

Steel-armored conductors should be continuous from outlet to outlet, without a splice. When it is desired to

Fig. 96. — Outlet box for armored cable.

tap a circuit this should be done by means of a junction box. At all outlets suitable outlet boxes must be used. Fig. 97 shows, at the left, a duplex enameled-iron bushing used in connection with the outlet box shown by Fig. 96, and at the right a single bushing used in switch boxes and at

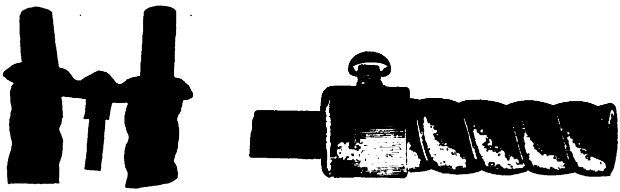


Fig. 97. — Bushing for outlet boxes.

panelboards. The sheathing of BX cable must be grounded, and at all outlet and switch boxes a clamp must be employed to hold the cable in place. This clamp may also serve properly to ground the cable. At panel centers the sheathing of the cables is connected together by means of a copper wire soldered to each cable as indicated in Fig. 98a. A good type of switch box for BX cable is shown by Fig. 98b.

To properly cut BX cable a fine hacksaw is necessary. Where dampness is present BXL cable should be employed. This cable has a lead sheath between the conductors and the steel armor and is especially applicable for stables and

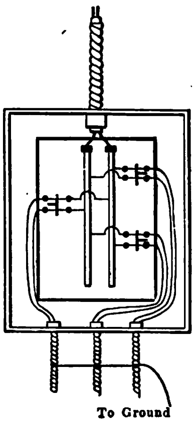


FIG. 98a.—Ground armored cable.

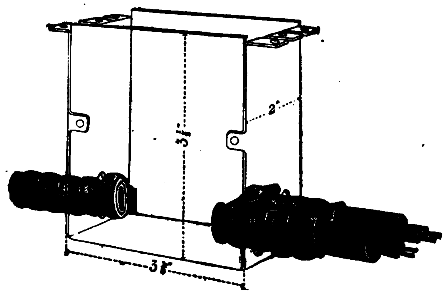


FIG. 98b — Clamp switch box for armored cable.

other places subject to fumes. This cable will not fit the outlet box illustrated by Fig. 96; a box similar to that shown in Fig. 90 may be employed, the single bushing shown by Fig. 97 being used at the outlet.

CHAPTER VII.

WIRING WITH IRON CONDUIT.

THE installation of electric wires in conduit is recognized as exemplifying the best practice known in the art. There are two kinds of conduit on the market — the lined and the unlined. The latter is used almost exclusively and is either galvanized or enameled with some insulating varnish. For out-door use or installations in damp places, and for work imbedded in cement, the galvanized conduit should be used. The code requirements permit the use of single-braided wire in lined conduit, but call for double-braided rubber-covered wire in the unlined conduit. Inasmuch as the lined conduit is fast becoming obsolete, the author in this article will treat only of the regular unlined type.

The use of iron conduit has resulted in standardizing various accessories and fittings, enabling the contractor to install a neat, safe and superior electrical installation without much trouble.

When laying out a conduit installation, the size of wire necessary for the various circuits should first be determined. Afterwards the necessary size of conduits to enclose the mains and feeders may be ascertained. The branch circuits are usually run in 0.5-inch conduit, since this is the smallest size permissible under the code rules, and since the branch circuits are usually of a size easily accommodated by a conduit of this dimension. It is usual to draw both wires of the circuit in the conduit regardless of whether the supply be alternating current or direct current. In the former case, the running of both wires of the circuit in the same conduit is mandatory, while in the latter case it is strongly recommended. Table IV shows the sizes of conduit required for various sizes of wire. Allowance has been made in this table for easy pulling of the wires around three elbows, so

TABLE IV. — CONDUIT FOR VARIOUS WIRE SIZES.

No. B. & S.	Cir. Mils.	Ampere Capacity.		Sizes of Pipe.		
		Rubber.	W. Proof. Open.	1 Wire.	2 Wire.	3 Wire.
				in.	in.	in.
18	1,020	3	5	½	½	½
16	2,583	6	8	½	½	½
14	4,107	12	16	½	½	¾
12	6,530	17	23	½	¾	¾
10	10,380	24	32	½	¾	1
8	16,510	33	46	½	1	1
6	26,250	46	65	¾	1	1¼
5	33,100	54	77	¾	1¼	1¼
4	41,740	65	92	¾	1¼	1½
3	52,630	76	110	¾	1¼	1½
2	66,370	90	131	¾	1½	2
1	83,690	107	156	1	1½	2
0	105,500	127	185	1	2	2
00	133,100	150	220	1	2	2
000	167,800	177	262	1¼	2	2½
0000	211,600	210	312	1¼	2	2½
	200,000	200	300	1¼	2	2½
	250,000	235	350	1½	2½	2½
	300,000	270	400	1½	2½	3
	350,000	300	450	1½	2½	3
	400,000	330	500	1½	3	3
	450,000	380	545	2	3	3½
	500,000	390	590	2	3	3½
	550,000	420	635	2	3½	4
	600,000	450	680	2	3½	4
	650,000	475	720	2	3½	4
	700,000	500	760	2	3½	4
	750,000	525	800	2	3½	4
	800,000	550	840	2	3½	4
	850,000	575	880	2½	4	4
	900,000	600	920	2½	4	4½
	950,000	625	960	2½	4	4½
	1,000,000	650	1000	2½	4	4½
	1,100,000	690	1080	2½	4	5
	1,200,000	730	1150	2½	4	5
	1,300,000	770	1220	2½	4½	5
	1,400,000	810	1290	3	4½	6
	1,500,000	850	1360	3	5	6
	1,600,000	890	1430	3	5	6
	1,700,000	930	1480	3	5	6
	1,800,000	970	1550	3	6	7
	1,900,000	1010	1610	3	6	7
	2,000,000	1050	1670	3	6	7

that in straight short-line runs, conduit a size smaller than specified may be used. Table V gives the actual inside and outside diameters and also the weight of standard conduit. The outside diameters are given so that the necessary size of drill and bit may be readily ascertained for drilling holes in panels, pull-boxes, etc.

TABLE V. — SIZES AND WEIGHTS OF CONDUIT.

Size Pipe.	Weight per 100 ft.	Diameter in $\frac{1}{64}$th Inch.	
		Inside.	Outside.
in.	lb.		
½	85	.39	.54
¾	112	.52	1.4
1	167	1.2	1.21
1¼	224	1.24	1.43
1½	268	1.38	1.58
2	361	2.4	2.25
2½	594	2.30	2.57
3	754	3.2	3.32
3½	900	3.34	4
4	1066	4.4	4.32

In laying out long runs, or runs requiring more than three elbows, a pull-box may be substituted for bends to advantage. The pull-box may be of iron or may be made of wood iron lined; the sheet-iron of the iron-lined pull-box should not be smaller than No. 12 gauge. Pull-boxes properly drilled should be made up and sent to the job, as workmen are liable to waste much time if required to make them on the job. When running a number of large conduits together, an angle pull-box is preferable to elbows. Elbows, especially if they are large, are quite expensive, and one pull-box may easily displace two or more elbows. Fig. 99 shows a pull-box substituted for three elbows. Another advantage of the pull-box over the elbow is that a size smaller conduit can often be used, owing to the absence of the elbow.

Conduits should always be of such size that wires may be easily pulled in. One of the objects of the conduit system is to provide a substantial raceway for the conductors. The

practice of pulling wires through a conduit by means of a block and fall is objectionable, and the underwriters should compile a table showing the smallest size of the conduit allowed for various sizes and groups of wires. It is evident

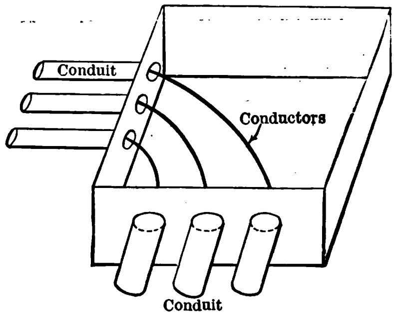


FIG. 99. — Pull-box.

that if wires are pulled in forcibly, the insulation becomes damaged and it is also next to impossible to pull them out again. This is especially true in very warm places, where if the conduit is too small and the lining softens because of the heat, the removal of the wires becomes very difficult indeed. In fireproof buildings, the conduit is run on the firebrick floors, the ends being bent so as to reach the outlet box, as shown in Fig 100. There should be no burrs in the conduit

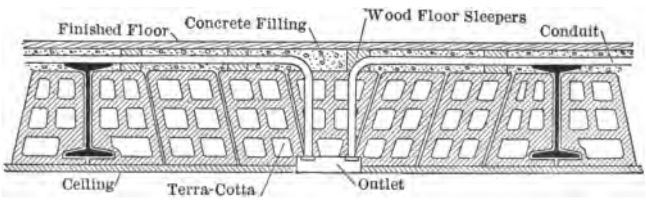


FIG. 100. — Outlet box in fireproof construction.

and all joints should be well screwed together. It is generally necessary to rerun the threads of the conduit in order that the joints may be well and rapidly screwed together. In a large installation, this work should preferably be done on a threading machine.

There are many devices on the market for bending conduit, but one of the chief disadvantages of these devices is that the conduit must be brought to them to be bent. For

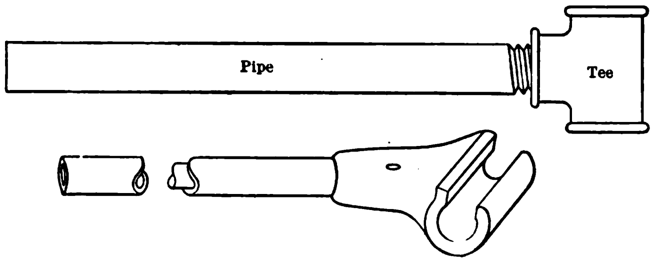


FIG. 101. — Two forms of hickey.

this reason, a very simple, efficient, and home-made device known as the "hickey" is extensively used. The hickey illustrated in the upper part of Fig. 101 is made of an ordinary T pipe-fitting, and a piece of pipe. The lower hickey is a

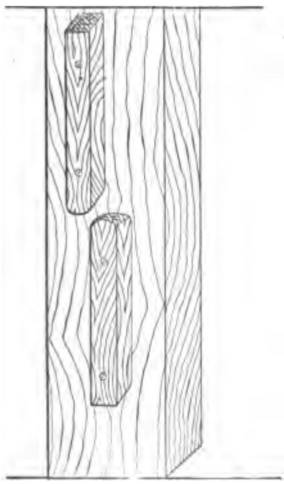


FIG. 102. — Conduit binder.

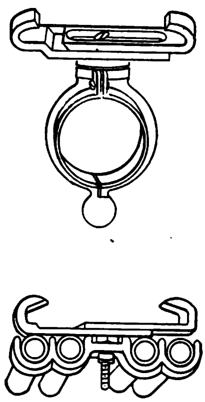
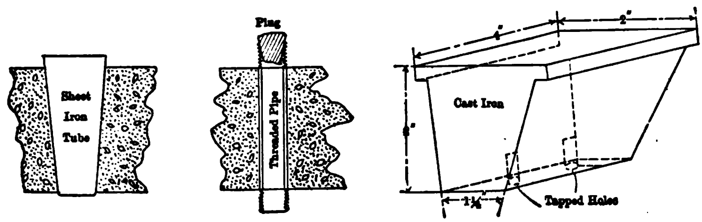


FIG. 103. — Pipe hangers.

commercial form. By means of either of these, the conduit may be bent while being laid. For bending large conduit, a heavy, substantial support, as shown in Fig. 102, is often

used. This consists of two pieces of wood, bolted to a column or other support in the manner shown. For fastening conduit to firebrick, ceilings or other plastered walls, toggle bolts are extensively used. In fastening conduit to a brick wall, expansion bolts and screws should be used. When running conduit on iron beams, girder hooks, fastened to wooden or iron supports may be used, or special girder clamps, of which there are a number on the market. Fig. 103 shows some forms of girder clamps for this work. In fastening conduit to wooden beams, the ordinary pipe-hook, staple or strap may be used, and in long, vertical runs, straps which securely grip the pipe are preferable.

A new class of buildings, made entirely of reinforced concrete, presents a new problem to the electrical contractor. This problem may best be solved by laying out the preliminary work when the building is being erected so as to avoid drilling of holes in the concrete as much as possible. If the wiring is to be concealed, the location of the outlets should be marked by a sheet-iron tube large enough to accommodate the conduit lines. This tube, properly plugged, may be set in the false work before the concrete is poured, as shown in Fig. 104. For risers a threaded piece of conduit of proper size should be put in the false work before the concrete is

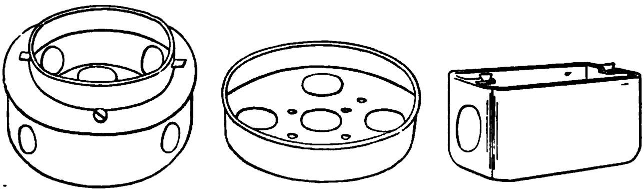


FIGS. 104, 105 and 106 — Devices for reinforced concrete buildings.

poured. This pipe should have a running thread so that the conduit can be readily joined to it. (See Fig. 105.)

For open wiring on concrete ceilings, a series of cast-iron supports should be set in the mold. These supports, one of which is shown in Fig. 106, should be drilled and tapped, and

when liberally used, form good supports for other piping as well. The supports should be inserted in the ceiling molds at regular intervals in order to obtain the greatest flexibility in installing the pipe lines. For use in connection with open-conduit wiring, outlet and switch boxes similar to those used



FIGS. 107, 108 and 109. — Outlet and switch boxes.

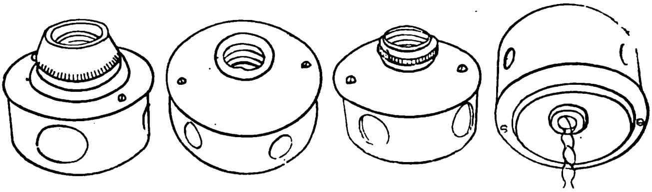
in concealed work should be used. Figs. 107, 108 and 109 illustrate a number of these.

It is very important that the insulating quality of the wire used in conduit work should be the best. Very often condensation takes place in a conduit and the insulating material deteriorates. In such cases the importance of having conduits of ample size is apparent. In running circuits requiring No. 12 and No. 14 wire, duplex wires are usually used. No wires should be drawn in the conduit system until the finishing coat of plaster is in place. This is done in order to test all the conduit after all the other work in the building has been completed. If no obstructions are encountered when pulling through the wires, it indicates that the conduit system has suffered no damage.

Where conduit is used outdoors or in damp places, a lead-encased wire should preferably be used. Great care should be exercised in drawing in the lead cables so as not to puncture the casing.

In all conduit systems the fittings such as outlet and switch boxes should be iron or iron-lined. The selection of fittings and the method of installing them are very important from the standpoint of cost. The fittings should be adapted for the purpose so that it will not be necessary for the wiremen to tinker with them. The iron outlet box should, for use in fireproof buildings, preferably be of stamped steel of the

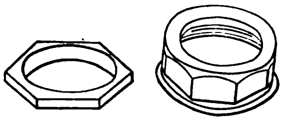
" knock-out " type. These boxes are made with a number of easily removable disks known as " knock-outs," any of which the wireman may knock out with a hammer, thereby giving him holes in any part of the box as may be required. Figs. 110, 111, 112 and 113 illustrate a number of outlet



FIGS. 110, 111, 112 and 113. — Outlet boxes.

boxes of this type. Boxes used in concealed work in fireproof buildings are fastened to the conduit by means of a lock-nut and bushing, and wherever a conduit terminates, the bushing must be used. Figs. 114 and 115 illustrate the standard lock-nut and bushing for this purpose. All boxes should be set so that the edges are flush with the finishing coat of plaster.

Switch boxes for the use of switches and receptacles should



FIGS. 114 and 115. — Lock-nut and bushing.

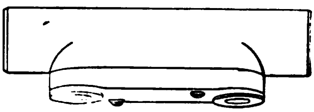


FIG. 116. — Cutlet fitting.

also be of the knock-out type, and securely fastened to the wall by means of toggle bolts or expansion bolts.

To supply the demand for a neater fitting, as well as a more substantial one, a new and distinctive line of outlet boxes, etc., covering a wide range of adaptability has recently made its appearance in the market. These fittings are made in a large variety, and while they would tend to complicate the already overburdened stock room, they are nevertheless a boon to the contractor. Fig. 116 illustrates an outlet fitting of this type which can be used to advantage

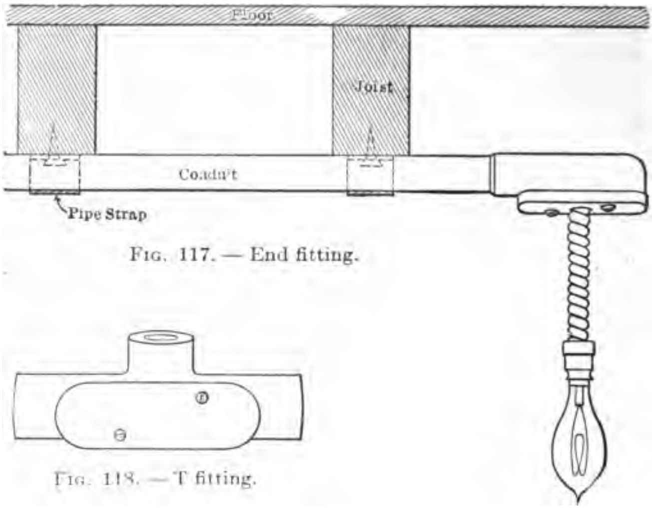


FIG. 117. — End fitting.

FIG. 118. — T fitting.

for outlets between beams. As the fitting screws rigidly to the conduit, no support is necessary. In buildings of mill construction this is a decided advantage. The cover of the fitting is interchangeable and either a drop-lamp fixture or a stem may be used. Fig. 117 illustrates an end fitting where an outlet also terminates the circuit. The end fitting used, as shown, requires no support, and besides saving time and money, presents a neat appearance.

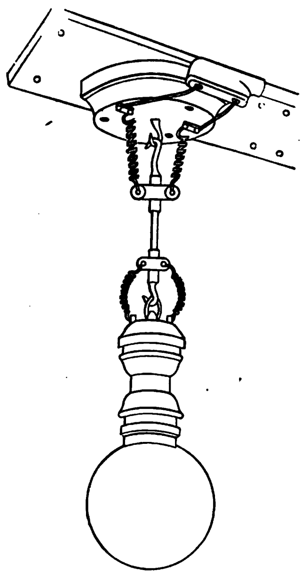


FIG. 119. — Arc-lamp wiring.

Fig. 118 shows a T fitting applicable for any branch work and also as a pull-box. Where it is desirable to continue open wiring from conduits, or the character of the wiring requires the conductors to be brought over from the conduit, as for instance in wiring an arc lamp, a good combination of these fittings, as shown in Fig. 119, may be employed.

The wires brought out from the conduit system are 2.5 inches apart, and thus a neat and safe job is secured. Fig. 120 shows a good elbow fitting, serving also as a pull-box, which is especially useful for wiring on wooden columns or making

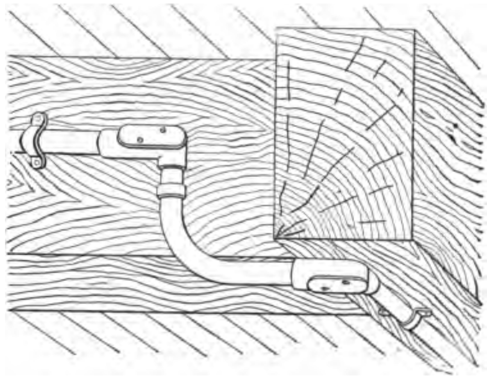
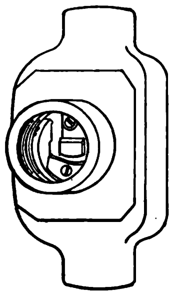


FIG. 120. — Elbow fitting.

complicated turns, since it does away with awkward elbow work. For wiring outlets in groups on outdoor awnings, a receptacle like that shown in Fig. 121 answers very well. It is advisable to make up these outdoor circuits in the shop so that all that remains for the wiremen to do is to screw the



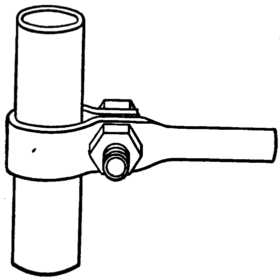


FIG. 121.— Receptacle for outdoor work. FIG. 122.— Ground clamp.

pipes in place. A good feature of this line of fittings is that they make good electrical contact with the conduit. Such is not the case with the ordinary outlet boxes, and since all conduit systems are required to be grounded, this is important. Fig. 122 shows a type of ground clamp applicable for

conduit work. The conduit should be scraped clean before the clamp is applied. Another clamp of this description should be fastened to a water main and the two joined together with a copper wire sweated in the lugs.

For terminating a conduit line outside a building, a fitting designed to prevent the ingress of moisture should be used.

Fig. 123. — Service entrance.

Fig. 123 illustrates a good device for this purpose, one advantage of which is that the porcelain cover spreads the wires the proper distance apart.

Where conduit terminates in a switch or panelbox, the lining or casing of the panels must be of iron, and the conduits should be securely fastened to it so as to make a good electrical contact. The ends of the conduit, of course, must be properly bushed.

CHAPTER VIII.

RESIDENCE WIRING.

THE electrical equipment of a residence presents a number of problems which, if successfully solved, add much to the income of the contractor and to the comfort of the inmates. The method of equipping and wiring a house depends, first, on the cost of the installation, and second, on the construction of the building. Buildings of wood-frame construction, especially those in the suburban districts, are often wired by means of the open-wire, porcelain-knob or tube method. This is the least expensive method of wiring, and though the writer does not recommend it, it is nevertheless largely employed. Other methods of wiring a house in course of construction employ flexible fiber conduits, flexible steel armored conductors, flexible steel tube, and solid iron conduits. In case the building is of fireproof construction, having steel beams and fireproof brick partitions, flexible steel conduits, or solid iron conduits are the only means available.

One of the most important and most profitable branches of residence work is the wiring of old houses which are being remodeled. In houses having wooden partitions flexible steel armored conductors are especially applicable. These can be readily fished from outlet to outlet and in addition to making a neat job make a safe one.

Below are given sample specifications for the electrical equipment of a four-story and basement house having wooden floors and partitions. There is nothing technical about these specifications, so that a contractor can submit them to a customer without any danger of their full intent and meaning being misunderstood.

In addition to the ordinary lighting equipment there

are given, in special paragraphs, specifications for the installation of devices which, though not essential to the equipment, are nevertheless much used. These special devices, if properly installed, are a source of much profit to a contractor. Following the specifications is an analysis of the various paragraphs. In case of special apparatus, drawings, wiring diagrams, and detailed description are given.

SAMPLE SPECIFICATIONS.

Scope of Contract. These specifications and the contract thereunder are intended to cover a complete electric lighting system, and include all the material and labor necessary to put the specified equipment in proper working order, but do not include the supplying or installing of the fixtures.

System. The system of wiring shall be that known as the three-wire system, having 240 volts between the outside wires and 120 volts between the neutral and outside wires.

Main Service Wires. From a point in the cellar where the illuminating company brings in its service wires to its service cut-outs, will be run a main wire which shall have sufficient section to carry the current required by the specified equipment with a loss not to exceed 2 per cent at the farthest outlet from the service wire, when all the lamps are turned on. This main wire will terminate in a service panelboard and shall be run in iron conduits.

Service Panel. There shall be located in the basement a service panel of marbleized slate, upon which shall be mounted one three-pole, single-throw knife switch of 100 amperes capacity, and fitted with enclosed fuses. There shall also be mounted on this board a double-pole, single-throw fused switch to control the motor circuit. There shall be space left on this board for the meter which the illuminating company will furnish and install.

Power Panel. There shall be located in the motor room a motor panel which shall be made of marbleized slate upon which shall be mounted four 50-ampere, double-pole fused knife switches.

Feeders. There shall be installed three feeders for electric lighting, as follows:

Feeder No. 1 to run from service board, through flexible steel conduits to the panel located on the first floor. Feeder No. 2 shall run from the service panel through flexible steel conduits to the panel located on the second floor. Feeder No. 3 shall run from the service panel, in flexible steel conduits to the panel on the third floor. Feeder No. 4, for motor work, shall run to the motor panel in the elevator room, in flexible steel conduits.

Panelboards. There shall be installed in the closet under the stairway on the first floor, a panelbox which will control the various circuits on the first and basement floors. There shall be installed on the second floor a panelbox to control the various circuits on the second floor. There shall be installed on the third floor a panelbox to control the various circuits on the third and fourth floors. The panelboards are to consist of marbleized slate upon which shall be mounted the bus-bars, switches, and fuses. Each circuit is to be controlled by a separate switch, and the fuses are to be of the plug type. There are to be supplied two additional circuits on each panel to provide for future extensions. These panelboards are to be set in boxes which shall be lined with $\frac{1}{16}$-inch sheet iron, which sheet iron shall be painted with a moisture repellent paint. There shall be a 4-inch gutter surrounding the panelboards, and the contractor is to supply an extra set of fuses of the proper capacity.

All switches are to be properly labeled, and there shall be a directory showing which circuit each switch controls.

There shall be furnished hardwood trims having door with tumbler lock and key. These trims are to match the surrounding woodwork, and are to be set flush with the wall.

Circuit Wiring. From the panelboards, as specified, shall radiate the various circuits supplying different outlets throughout the house. The circuit wiring shall be done with flexible steel-armored conductors. Each circuit is

to feed not more than 10 lamps of 16 candlepower each, excepting where an outlet has 12 such lamps. These conductors are to run from outlet to outlet without being spliced or tapped, and shall terminate in an improved iron outlet box. Outlet boxes shall be of cast iron and neatly and securely mounted so as to be flush with the plaster and be capable of supporting a fixture of reasonable weight.

TABLE VI.—SUMMARY OF OUTLETS.

	Side Outlets.	No. of Lamps.	Center Outlets.	No. of Lamps.	Switches.	Receptacle.
Cellar	2	2	1	1	...	...
Kitchen	2	4	1	2	1	...
Laundry	1	1	1	1	...	...
Servant's room	...	...	1	2	1	...
Toilet	1	1	...	...	...	...
Rear hall	1	1	...	...	...	...
Front hall	2	2	...	...	...	...
First floor.						
Vestibule	...	...	1	3	...	...
Reception hall	3	6	...	...	1	2
Parlor	4	12	...	...	2	3
Dining room	4	12	1	8	2	2
Pantry	1	1	1	1	...	...
Rear hall	1	1	...	...	...	...
Second floor.						
Library	4	12	1	6	2	2
Music room	2	4	1	4	1	...
Owner's bedroom	2	6	1	6	2	1
Bedroom	2	4	1	4	1	...
Bedroom	2	2	1	1	1	1
Front hall	2	2	...	...	...	...
Rear hall	1	1	...	...	...	...
Third floor						
Bedroom	2	6	1	3	1	...
Bedroom	2	6	1	3	1	...
Bedroom	2	4	1	2	...	...
Bathroom	1	2	...	...	...	...
Nursery	2	4	1	3	...	...
Rear hall	1	1	...	...	...	...
Front hall	2	2	...	...	...	...
Fourth floor.						
Servant's room	1	1	...	...	...	...
Servant's room	1	1	...	...	...	...
Servant's room	1	1	...	...	...	...
Hall	1	1	...	...	...	...
Bathroom	1	1	...	...	...	...
Billiard room	2	4	...	...	...	...
Store room	1	1	...	...	...	...
Summary	57	99	17	54	16	13

Switches. There shall be installed, as indicated on the plans and as enumerated below, flush switches which shall be of the —— or an equally good type. These switches are to be placed in improved steel outlet boxes, which set in the walls flush with the trim. They are to be furnished with surface plates to match the surrounding hardware.

Receptacles. There shall be installed in locations described on plans, and as enumerated below, flush wall receptacles which shall be of the —— type. These receptacles shall be set in the surbase or trim, in locations as directed. These receptacles shall be set in steel outlet boxes and have surface plates to match the surrounding hardware. They shall also be supplied with proper plug connections ready for the extension cords.

Damage Clause. All wiring specified is to be installed so as not to damage the walls or ceilings except where rooms have side outlets, and where these side outlets are located on brick walls. In this case it is necessary to channel the walls, and the contractor is not to be held responsible for this damage.

Inspection. All work to be done according to the rules and regulations of the National Board of Fire Underwriters and any local boards having jurisdiction. The contract is not to be considered complete until proper certificates have been furnished.

Below are given specifications for a number of special devices which are very frequently used:

Electric Pump. There shall be furnished and installed in the cellar one electric pump which shall be of sufficient capacity to pump 500 gallons of water per hour. The motor shall be of 0.5-horsepower capacity and directly connected to the pump. This motor is to be automatically controlled by a tank switch and float, which should be located on the tank on the roof. The tank switch is to be housed, so as to protect it from the elements. There shall be located at a point convenient to the pump, a switch, by means of which the motor can be operated independently

of the tank switch. All wires connecting the automatic tank switch with the motor shall be run from the cellar to the roof in flexible steel conduits. There is to be supplied with the pump the usual manufacturer's guarantee, and all necessary fittings. Price does not include the connecting of the pump to the water supply. All piping is to be done by other contractors.

Electric Heating Apparatus. There shall be furnished and installed in the butler's pantry, a plate warmer of — inches, having two shelves. These shelves are to contain the necessary apparatus for heating the plate warmer to — degrees Fahr. in — minutes. This plate warmer is to be controlled by a switch so that either shelf can be used singly, or both at once. There is to be installed a proper indicating switch, having sufficient capacity to carry the current. There shall be run from the switch controlling this plate warmer, to the motor panelboard in the basement floor, wires of sufficient capacity to carry the current necessary to supply the heater. These wires are to run in a flexible steel conduit.

Sad Irons. There shall be furnished and installed in the laundry a holder which shall take six irons, and which is electrically heated. This holder shall be controlled by an indicating switch and shall be connected to the lighting panel on the first floor. There shall also be furnished a single self-contained electrically-heated iron, having a flexible cord which can be attached by means of a plug. This iron shall be 8 inches long and weigh 6 pounds. The handle is to be so arranged that the iron is cut out of circuit when released by the operator.

Hall Lamps. There shall be installed in each hall an outlet for an electric lamp, controlled by "four-way" switches; so that it shall be possible to light the lamps in each of the halls by pushing a switchbutton in any hall, or extinguish all the lamps in the halls by pushing the turn-off button of any of the "four-way" switches in the halls. These switches shall be of the ——— type, set flush with the wall in iron outlet boxes, and shall be controlled from the first-floor

panel. All wiring for same is to be done with flexible steel armored conductors. (Fig. 124 shows such a circuit.)

Closet Lamps. There shall be installed in the three closets herein specified closet switches. These switches shall be set in the door-jambs of the closets, in iron boxes. They are to be arranged so that upon opening a closet door a switch will light a lamp placed inside the closet. This lamp shall be mounted in a key receptacle, which, in turn, shall be

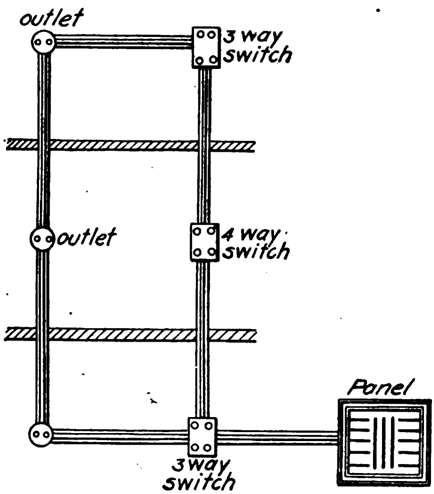


Fig. 124. — Arrangement for hall lamps.

mounted on an iron outlet box by means of a suitable plate. All wiring to be done with steel-armored conductors.

Automatic Main Switches. There shall be located on the service panel in the cellar a three-pole, automatic, solenoid switch, which shall be connected in the main circuit so as to control all the lamps in the house, except the hall lamps. This automatic solenoid switch is to be operated by a switch located in the owner's bedroom, and is to be arranged so that by pressing the "off" button all lamps excepting the hall lamps will be disconnected from the service. The solenoid switch shall be rigidly mounted on a backboard and

shall be enclosed in an iron-lined box. There shall be furnished in connection with this switch a special panel so arranged that the hall circuit is supplied whether the switch

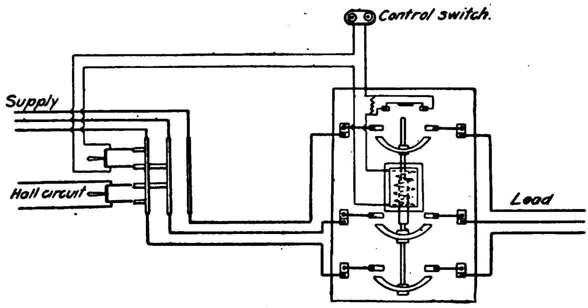


FIG. 125. — Solenoid switch for controlling lamps.

is on or off. The wires running to the control switch in the owner's bedroom are to be of the flexible steel conductor type. (Fig. 125 gives diagram of such a device.)

Stained Glass Window Lighting. There shall be installed to light the stained glass windows on the first floor, eight 16-candlepower lamps, so arranged that the entire surface of the window will be equally illuminated and so that no blotches of light shall be visible. These lamps are to be controlled by a flush switch located in the trim under the window sill, and will be connected to the first-floor panel by means of flexible steel conductors.

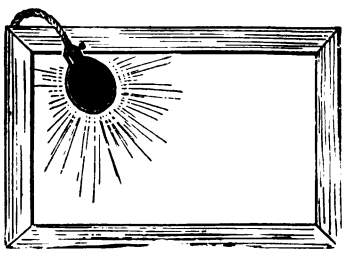


FIG. 126. — Picture reflector.

Picture Lighting. There shall be furnished and installed —— reflectors to light pictures located in —— rooms, as

follows: ——. These reflectors are to be finished the same as the picture frame, and are to be adjustably mounted on the frame. They are to be connected by means of flexible

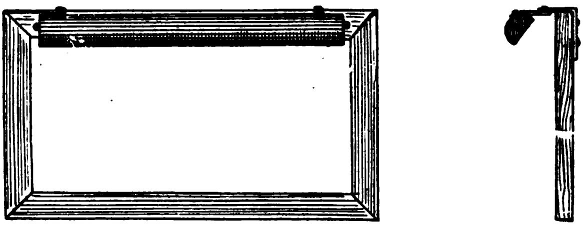


Fig. 127. — Picture reflector.

cords to flush receptacles behind the picture. (Figs. 126 and 127 illustrate types of picture reflectors.)

Ceiling Lamps. The parlor ceiling is to be illuminated by lamps concealed in a cove or cornice, the lamps to be arranged so that each alternate lamp forms a part of one group controlled by a separate switch. All wiring is to be done by means of flexible steel conduits, and iron outlet box connected to the panelbox on the first floor.

Ventilating. There is to be installed in the cellar an electric motor direct connected to a 36-inch fan which is to be placed in a galvanized-iron duct so as to exhaust into the yard. The galvanized-iron duct is to connect with the various rooms from which it is desired to exhaust the vitiated air. This fan motor shall run at 550 rev. per min., and shall be capable of discharging 12,500 cubic feet of air per minute. The wires for the motor are to be run in iron conduits and to be connected to the motorboard in the cellar. There is to be located in the butler's pantry, a knife switch and automatic release rheostat for the control of this motor. The wiring for the same is to run in iron conduits.

Polishing Motor. There shall be located in the basement a 0.5-horsepower motor having extended shafts on each end which shall form spindles upon which can be placed polishing buffs. This motor is to be dustproof and

securely mounted on a pedestal 4 feet high and having a hood of galvanized iron to collect the particles of dust. The motor to run at a speed of 2,800 rev. per min., and is to be controlled by switch and rheostat conveniently located near the motor. All wires to be run in iron conduits, and energy is to be supplied from the motor panelboard in the elevator room. An outfit of this kind is shown by Fig. 128.

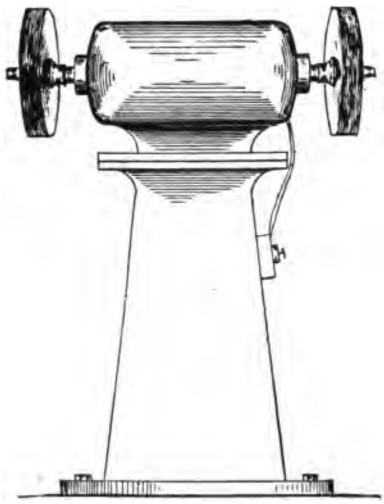


FIG. 128. — Polishing motor.

Electric Dumbwaiter. There shall be furnished and installed in connection with the present dumbwaiter an electrically controlled dumbwaiter as follows: The dumbwaiter is to run from the basement to the second floor and is to be controlled by means of pushbuttons located on each of the three floors. These pushbuttons shall be so arranged that by pressing the button marked No. 1, the dumbwaiter will automatically start and go to the first floor, and automatically stop. The switches are to be arranged so that if the elevator has once started it shall be impossible to interfere with its operation by pushing any other button. There shall be installed in connection with this dumbwaiter, door switches. They shall be connected so that it will

be impossible to operate the dumbwaiter while any of the doors are open. The automatic mechanism operating this motor shall be located in the basement and shall be protected by a grating to prevent meddling with the automatic adjustments. The car shall travel at the speed of 60 feet per minute and shall be capable of lifting 50 pounds. All wiring to be run in iron conduits, with proper outlet boxes for the pushbuttons, and to be supplied with electrical energy from the main feeder in the elevator room.

Special Decoration Lighting. There shall be installed in the locations specified, flush plug receptacles which shall be controlled by flush switches, so that portable lamps or decorative lamps for special purposes can be quickly connected without any extra circuit wiring.

Analysis of Specifications.

System. It is important to specify the system of wiring, as there are sometimes several methods of wiring applicable to an installation. Take, for example, the three-wire system. The three conductors may be of the same size, or the neutral conductor may be twice the size or equal to the combined capacity of the outer conductors. This is called the three-wire convertible system, the advantage of which over a straight three-wire system is that at any future time should the source of supply be changed to a two-wire system the main conductors or feed wires can be changed to a two-wire system by using the neutral wire as one conductor and joining the other two wires and using them as the other conductor. In wiring large buildings which intend to use central station service, it is always advisable to install the convertible system so that it would be possible at a future time, should the rates become such as to make it advisable, to install a private plant. It is an easy matter to change from the three-wire system to a two-wire system with a slight additional cost for panelboard and switchboard connections.

Main Service Wires. Main service wires are usually run inside of iron conduits as either flexible or solid conduit

is easily installed on the ceilings of basements on which the main service wires usually run. In small installations where only one distributing center is used the main wires are sometimes omitted, and a panelboard, from which all the circuits radiate, is installed where service wires enter. This method of service connection is frequently used in houses of frame construction, where the service wires are brought in through overhead wires to the attic. At the point of entrance a switch is installed, and from the switch, wires to the panelboxes through a meter loop. If the house is a small one, this is the best and cheapest method of feeding, but should not be used where the building is large.

Service Panel. A service panel is a convenience and not used very frequently, as it is not a vital part of the installation. It affords a neat and workmanlike way of distributing the current and making meter connections. The panels should be built according to standard switchboard specifications, and the number of feeder switches depends upon the number and size of feeders in the installation.

Motor Panel. In houses using electric elevators and motors the motor panel is a convenience though not an essential part of the installation. A motor panel should contain the necessary number of switches with fuses for the installation, and it is also well to have one or two separate switches. These separate switches are convenient for further additions, such as electric motors or electric heating apparatus, which should be connected to the same panel as the motors.

Feeders. Feeders should be run from the service panels to the panelboards. The best method is to use a separate feeder for each panel, as in case of trouble to one feeder the balance of the installation is not put out of service. When the number of lamps in the installation is not large, and the expense of separate feeders is too great, one feeder can be run to all panels. In case of a large installation, where a great number of lamps are taken off at the first or second panel, the size of the feeder up to the first panel, of course, should be large enough for the entire installation. From

this panel to the next panel the size of the feeder can be reduced, but in making such reduction it is necessary to provide fuses on the panelboard, as according to the underwriters' rules it is necessary for a fuse to be put in when reducing the size of a wire in order that smaller wires may be protected. This makes the panels somewhat more expensive, and it is often advisable, unless there is a very material saving in wire, for a contractor to use a uniform feeder on such an installation, as the construction of the panel with fuses adds an additional cost which counterbalances the saving on the feeders.

Panels. Panelboards specified in this installation are designed for plug fuses. For private-house wiring the plug fuses are best, as they are easily renewable by unskilled hands, without danger. Link fuses should never be installed in a private house, as it is dangerous for anybody but an experienced person to replace them. Blowouts generally occur in the evening, when experienced help is not easily obtainable, and when they cause considerable inconvenience. It is readily seen that the plug fuse with mica front indicating which fuse has blown is the proper one to use. The location of panelboards in private houses is a matter which requires some care. While they should not be put in conspicuous places they should nevertheless be accessible. Closets are sometimes used, but are very bad places, especially if link fuses are used. Should the door of the panelbox be left open a blow-out would easily cause a fire. Panelboards are sometimes set into cabinets of wainscoting so as to conform to the general decorative scheme of the rooms. Hallways are excellent places for panelboards, and the trim or frame if set in woodwork should be made similar to the surroundings so as not to be distinguishable. There should always be one or two spare circuits on a panelboard for future additions, also a directory showing the lights which each circuit feeds.

Circuit Wiring. These circuits radiate from the panel centers, and the flexible cable must be continuous from panel to outlet and from outlet to outlet. Steel-armored cables

are made in various sizes from two No. 6 wires to two No. 18 wires. The usual sizes carried in stock for circuits are No. 12 and No. 14. Wherever the circuits are 100 feet long or over, it is advisable to use No. 12 cable, in order to provide for the extra drop of potential caused in the long run. It is not advisable to put more than ten 16-candlepower lamps to a circuit in a new installation, in order to provide for additions, and as the code restricts circuit wiring to 660 watts or twelve 16-candlepower lamps, if the capacity is used up at the start, any additional lamps must be wired up to the panelboard, which is very expensive, especially if the house is finished. In case one outlet is for twelve lamps it naturally would be advisable to use up the circuit capacity. Outlet boxes must be used in this work. Fig. 96 shows a good make of outlet box for use in connection with flexible steel cable. Bushings must be provided, as shown in Fig. 97, and bushing for use in connection with the switch outlet box is shown by Fig. 98. Outlet boxes should be set flush with the plaster, and those provided with studs for electric fixtures only should be securely fastened to a beam or other support so as to sustain any reasonable weight of fixture.

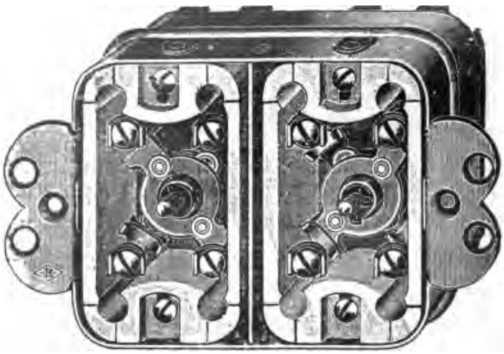
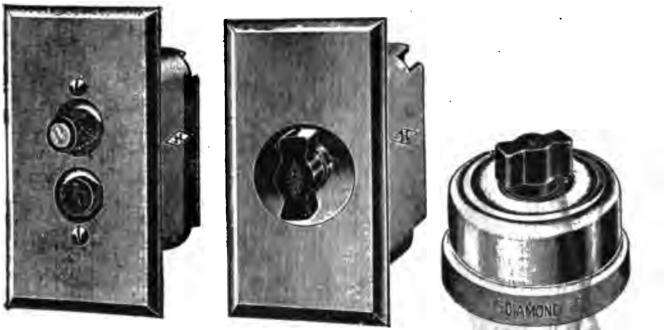


Fig. 129. — Gang switches.

Switches. Flush switches of the push type are the most desirable form of switch to use in private-house wiring, as they are indicating to the touch as well as to the eye.

They must be mounted in iron or steel outlet boxes, and where more than one switch is mounted at one place, gang boxes are furnished, as shown by Fig. 129. A number of other forms of switches are illustrated in Figs. 130, 131 and



Figs. 130, 131 and 132. — Electric lamp switches.

132. Switches should be mounted 4.5 feet from the floor, unless the nature of the trim or decoration makes other dimensions necessary. They should be located so that the lamps are controlled at the entrance to the room. Hall and cellar lamps should be controlled from the stairway leading to the hall, or cellar. Where it is necessary to control a large group of lamps, as, for instance, a large ball room or hall, from a single flush switch, it is necessary to install a solenoid switch operated from a pushbutton switch.

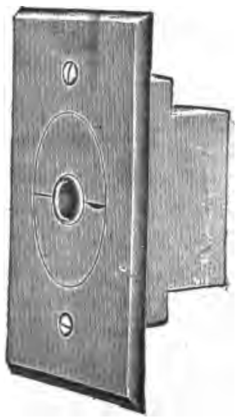


Fig. 133. — Flush receptacles.

Receptacles. In designing the electrical equipment of a house, receptacles are a very important part of the layout. They should be installed in all important rooms, so as to allow for decorative lighting at banquets, and for connecting piano lamps, and other electrical devices.

Fig. 133 illustrates a convenient form of receptacle which is flush when the plug is inserted. These receptacles must be mounted in steel or iron boxes, as in the case of switches. Receptacles are usually set in baseboards excepting when desired for picture lighting, when they are sometimes set on top of wainscoting or mantels. Reinforced flexible cord must be used in connection with the plugs. These flexible cords are usually covered with different colored silks so as to harmonize with the prevailing color of the room.

Damage Clause. When a contract is taken with the understanding that the work is to be done without injuring the decorations, the damage clause is important to the owner, and the restrictions named therein equally important to the contractor. In a damage clause of this kind the contractor must carefully ascertain the character of the partitions and construction of the buildings and must exercise especial care if there are many hardwood floors, since hardwood floors are difficult to relay, even by experts. If the house is furred it is easy to fish the conductors from outlet to outlet. The great difficulty is in installing switches and receptacles, as the studding very often interferes with bringing down the cables. It is sometimes necessary to bore from the floor above to the casing of the doors, which are usually hollow, and fish the cable into them. Brick side-wall outlets must be excepted in the damage clause, as it is impossible to avoid channeling these walls with a cold chisel, in order to install the cables. Where these walls are outside walls, and exposed to dampness, it is necessary to use lead-encased flexible conductors. Some of the inspection departments require a steel slashing consisting of $\frac{1}{16}$-inch steel to be placed over flexible steel conductors where laid in brick walls. This is done as a protection against carelessly driven nails. In estimating on a contract of this kind, these points should be kept in mind.

Inspection. The contractor, cf course, must agree to comply with the rules of such of the inspection offices as have jurisdiction in his neighborhood, and furnish the proper

certificate. The rules of the National Board of Fire Underwriters are those used by practically all the Inspection Bureaus throughout the United States.

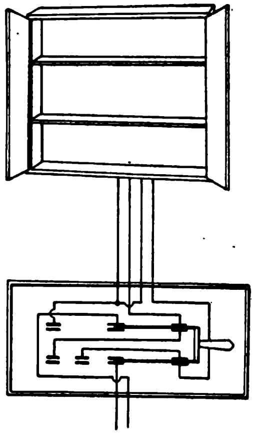


FIG. 134. — Plate warmer.

Summary of Outlets. The summary of outlets should contain a complete list of the outlets and their location, together with the number of lamps, switches, and receptacles.

Electric Plate Warmer. The electric plate warmer illustrated in Fig. 134 is made of sheet iron and nickel fittings, and has two heating shelves. These heaters consume one watt of power for every square inch of surface. To control the plate warmer a special-designed, double-throw knife switch should be used, as shown in Fig. 135. The clips are cross-connected on the back in such a manner that it is possible to throw the heaters in series, to obtain a medium amount of heat, and in parallel, to obtain the

FIGS. 135 and 136. — Special switches for plate warmers.

full heating effect. The switch is very often mounted on the side of the plate warmer, and should be placed in a box lined with $\frac{1}{16}$-inch sheet iron. A very good form of switch made for this purpose is shown in Fig. 136.

Electric Pump. The electric pump shown in Fig. 137 is driven by a 0.5-horsepower motor directly connected to the shaft of the pump. The enclosed tank switch, which is single-pole, opens and closes the circuit under the

action of a float. An iron-lined box contains two knife switches, one of which closes the circuit of the motor, independent of the tank switch. This is often necessary in order to test the motor, and to pump water, should the tank switch get out of order. The top jaws of this switch

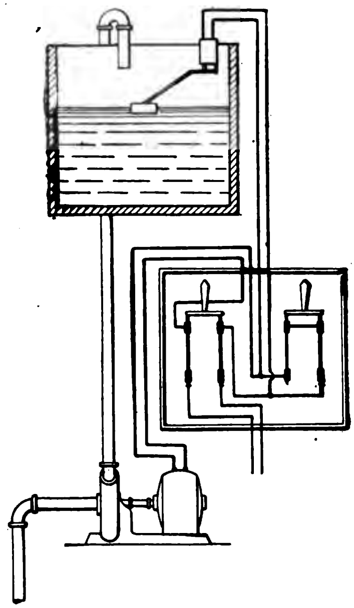


FIG. 137. — Connections for house pump.

are short-circuited. The tank switch closes the circuit direct to the motor, as a 0.5-horsepower motor can be started without a starting resistance. In the case of a large motor, however, it would be necessary to use a starting resistance, and as this would have to be operated automatically the tank switch would be used to close the circuit of an automatic solenoid starter.

Stained Glass Window Lighting. Stained glass windows are always a difficult subject for proper illumination. The window should be illuminated equally in every part, and in order to get this effect it is necessary to have a white

background. This is easily obtained by using a canvas curtain, which, if exposed to the weather, should be protected by a metal hood, as shown in Fig. 138. It will be noted that the curtain is hung at an angle. This is done to equalize the illumination and light the bottom of the

FIG. 138. — Stained glass window lighting.

window as brightly as the top. The lamps and reflectors should be so mounted as to throw the light down, and at the curtain. The reflector should be out of the line of vision when standing three or four feet from the window; in other words, the source of light should not be visible at all. If the glass in the window is translucent it is sometimes necessary to mount lamps all around the window casing. If the light is projected on the curtain by reflectors a very beautiful effect is obtained. If the window is in the front of the house so that a canvas curtain would be unsightly, a metal shutter, painted white on the inside, may be used. This shutter, at the same time, acts as a protection to the window.

Ceiling Lamps. The ideal way of illuminating a room is by concealed lamps. This, of course, requires a great

many more lamps than direct lighting, and is, therefore, much more expensive. The design of the ceiling must be such as to give the right amount of space for the lamps. The contractor should furnish the architect with a print showing just how much space he requires for the reflectors and wiring. The lamps should be hidden from view, and

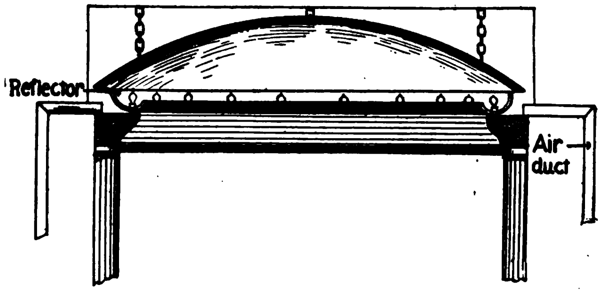


FIG. 139. — "Cove" ceiling lighting.

should be wired so that each lamp will be on an alternate circuit so that it is possible to get an equal diffusion of light with half the number of lamps, in case maximum brilliancy is not desired. In connection with ceiling lighting it is important to ventilate the ceiling by means of ducts properly connected to an exhaust fan, as indicated by Fig. 139. The troughs for reflectors, to be used with ceiling lamps, may be made very narrow so as to take the socket and a tubular lamp. This trough should have corrugated mirror reflectors, as it is necessary to get the greatest amount of illumination.

CHAPTER IX.

WIRING FOR DIRECT-CURRENT AND ALTERNATING-CURRENT MOTORS.

THE installation of electric motors is an important and profitable branch of the contractor's business, and if the number of orders is sufficient the installation work should be in charge of a competent special foreman.

Direct-current motors for ordinary work are either shunt-wound or compound-wound. For regular work the shunt-wound motor is usually furnished, and it has installed with it an automatic-release starting box.

Motors should be installed in dry locations, and not in dirty or dusty places or near inflammable gases. If location in a dusty place is unavoidable, the motor should be housed in a dustproof sheathing, or an enclosed type of motor

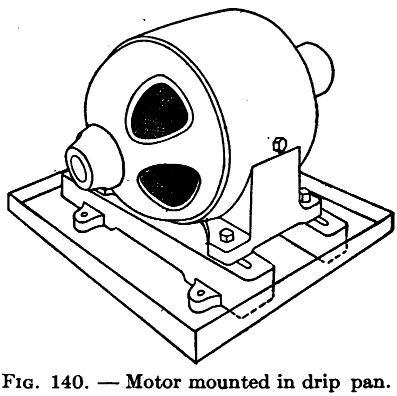


FIG. 140. — Motor mounted in drip pan.

should be used. Enclosed motors, owing to the temperature rise due to lack of ventilation, have a lower rating, size for size, than regular motors.

In some localities motors are required to be mounted on drip pans as illustrated in Fig. 140. Sliding rails are used

in connection with belted motors, so as to take up the slack of the belt.

A good plan is to fasten motors on the ceiling. This method saves considerable floor space and eliminates the danger of the running belt. To hoist the motor in position, remove the flooring directly over the place where the motor is to hang, and mount the tackle on the ceiling of the next floor or on a support. The motor can be then easily aligned

FIG. 141. — Automatic starting panel.

and bolted in position. In mounting a motor on the ceiling the bearings must be turned so as to bring the oil cups in their proper position.

The automatic or no-voltage release starter must be mounted on a slate or marble backing, and the form of the starter should be such as to allow of the fullest air circulation on all sides. A good plan is to mount the switch with its fuses and circuit-breaker on the same panel with the starter. Such panels are on the market and are neat as well as substantial, as illustrated in Fig. 141.

Wiring to motors should preferably be run in iron conduits, especially where motors are located on floors, but other approved methods of wiring answer as well if properly

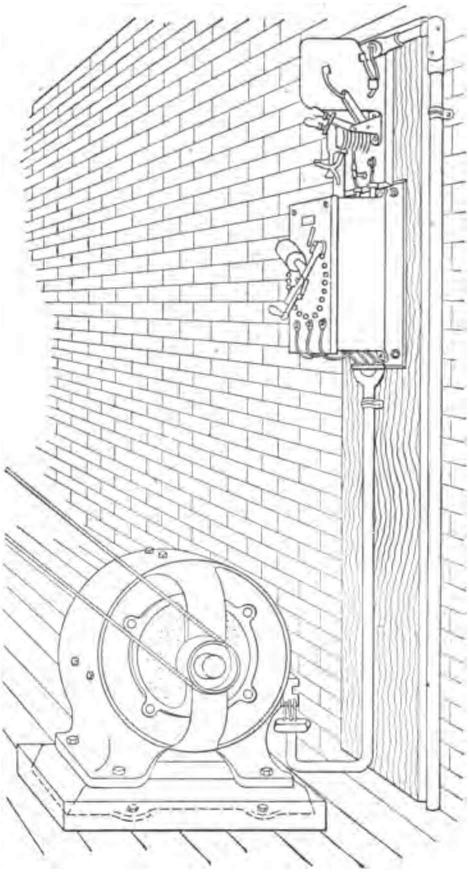


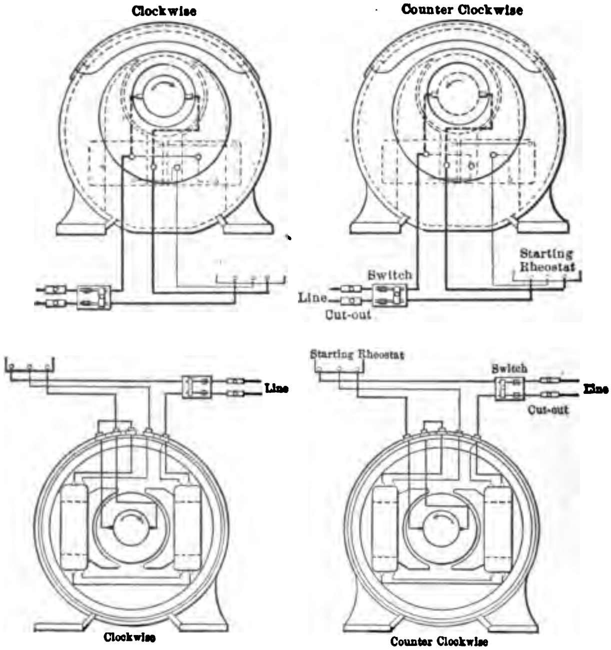
FIG. 142. — Conduit-wiring scheme.

installed. Fig. 142 illustrates a conduit-wiring scheme using terminal fittings which spread the wires.

If motors are to be used to run elevators, in connection with automatic or solenoid starters, or if they are required to start under a load, a compound-wound motor should be installed.

To change the direction of rotation of a shunt-wound

motor, reverse the brushes and interchange the field leads as shown in Fig. 143. The direction of rotation of compound-wound motors may be reversed in a similar manner, as shown in Fig. 144.



FIGS. 143 and 144.—Method of reversing a shunt-wound or compound-wound motor.

Motor connections should be carefully made and tested before the machine is switched into the circuit, as a motor is very easily damaged by starting under improper conditions. It is of primary importance that the resistor is in series with the armature circuit. This is necessary to prevent excessive current in the armature, which has a low resistance and would consequently be destroyed. As soon as the armature is speeded up, the counter e.m.f. generated increases, and the resultant e.m.f. produces a less current in the armature circuit.

The no-voltage or automatic release on the starting-box

is a very important adjunct. Without it, should the circuit be momentarily interrupted and then closed again, the excessive current through the armature, starting with no resistor in circuit, would either burn out the armature or blow the fuses.

In wiring motors in connection with automatic starting devices, the diagrams and instructions furnished by the manufacturer should be followed. The ordinary wireman frequently makes errors, especially in making connections from diagrams. A good plan is to tag the motor terminals and special device terminals in the following manner: A to A–1, B to B–1, etc., putting proper tags on each terminal.

For varying the speed of motors many methods are used. In connection with some motors, a resistor of considerable resistance is used in the main circuit. Another plan is to insert a resistor of variable resistance in the field circuit, whence by varying the strength of the field the speed is naturally changed. There is a great variety of special variable-speed motors on the market. In wiring these motors in circuit the diagrams and instruction blanks furnished by the builder should be carefully followed.

As the current initially taken by a motor is considerably greater in value than the normal running current, the fuses or other safety devices, such as a circuit-breaker, should be sufficiently large to take care of this initial rush. Table VII gives the rating of various motors, showing their normal full-load current and the rated capacity of fuses to use.

TABLE VII. — FUSES REQUIRED FOR VARIOUS MOTORS.

Horse-power of Motor.	Full-Load Current at 115 Volts.	Ampere Rating of Fuses Required.	Full-Load Current at 230 Volts.	Ampere Rating of Fuses Required.	Full-Load Current at 550 Volts.	Ampere Rating of Fuses Required.
2	16	25	8	20	3½	10
3	24	35	12	25	5	15
5	39	60	19	40	8	20
7½	57	75	28	50	12	25
10	75	100	37	60	15½	30
15	113	150	55	75	23	35
20	151	175	74	100	31	40
25	188	225	92	125	38	50
30	226	275	111	150	46	60
40	300	350	148	175	62	80
50	374	450	185	225	75	100

Circuit-breakers are sometimes used in place of a switch and fuses, and though the initial cost is greater, their use, where permitted, is cheaper in the end, as there are no renewals required as when fuses are used. The code requirements, however, call for fuses in connection with circuit-breakers, except on main switchboards.

In selecting a direct-current motor for a customer consideration for future requirements should be taken into account. If belted or geared to a fixed load, the motor should be the nearest standard size relative to the load. A standard motor operates at its maximum efficiency at or near full load, and the efficiency is reduced when operating under partial load. If the motor is belted to a line of shafting driving a number of machines, the average load should be taken, plus a reasonable allowance for additions.

Motors geared direct to machinery make an ideal drive. Geared motors should be run at as low a speed as possible. Motors of a certain horsepower rating may be obtained with two or three speeds. The motor having the lowest speed should be used for geared work. The pinion on the motor should be made of rawhide, so as to minimize the noise and wear on the gearing. A silent chain-drive may also be used to advantage with geared motors. In calculating the size of gears required for various speeds, the same formulas apply to the silent chain-drive as to gears.

$$\frac{\text{number of teeth} \times \text{speed of gear}}{\text{number of teeth in pinion}} = \text{speed of pinion.}$$

$$\frac{\text{number of teeth} \times \text{speed of pinion}}{\text{number of teeth in gear}} = \text{speed of gear.}$$

$$\frac{\text{number of teeth} \times \text{speed of gear}}{\text{speed of pinion}} = \left\{\begin{array}{l}\text{number of teeth in}\\ \text{pinion}\end{array}\right.$$

$$\frac{\text{number of teeth} \times \text{speed of pinion}}{\text{speed of gear}} = \left\{\begin{array}{l}\text{number of teeth in}\\ \text{gear.}\end{array}\right.$$

The following formulas may be used for determining the size of pulleys required for various speeds:

$$\frac{\text{diameter} \times \text{speed of driven pulley}}{\text{speed of driver}} = \text{diameter of driver.}$$

$$\frac{\text{diameter} \times \text{speed of driving pulley}}{\text{speed of driven pulley}} = \left\{ \begin{array}{l} \text{diameter of driven} \\ \quad \text{pulley.} \end{array} \right.$$

$$\frac{\text{diameter of driver} \times \text{speed}}{\text{diameter of driven pulley}} = \left\{ \begin{array}{l} \text{speed of driven} \\ \quad \text{pulley.} \end{array} \right.$$

It is a good plan to install devices for stopping the motor from a number of distant points in a factory. Such a device will often prevent a serious accident when an employee is caught in belting or gearing. Numerous commercial devices fitted with push-button control are manufactured for this purpose. Fig. 145 illustrates a home-made device which

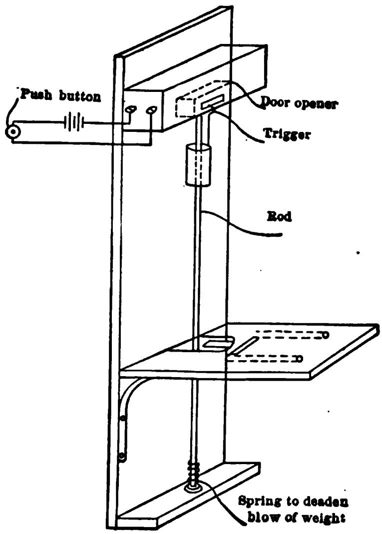


Fig. 145. — Safety stop for a motor.

has been found to be reliable, as well as inexpensive. It can readily be assembled by any carpenter. An ordinary electric door-opener is mounted as shown, in connection with a knife switch of proper size. A weight sliding on a rod, and having a trigger, is released when the magnet of

the door-opener is energized. This weight in falling strikes the switch handle and consequently opens the circuit. Any number of pushbuttons connected in multiple can be used to operate this device. Two or three ordinary dry cells are used to operate the door-opener circuit. Fig. 146 illustrates a good type of circuit closer for emergency use.

Automatic solenoid starters are used when motors are to be started or stopped automatically or from a distance. One of the most frequently used applications of this type of starter is in connection with belt-driven elevators. Fig. 147 shows a type of starter suitable for such use. A "belt switch" is required to close the solenoid circuit. This belt switch is connected as indicated, and the outfit makes a very satisfactory installation.

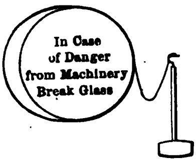


FIG. 146.—Circuit closer for emergency use.

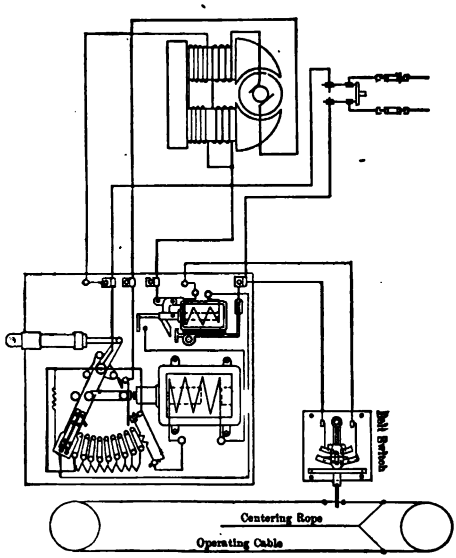


FIG. 147. — Automatic solenoid starter.

The alternating-current motors on the market may be divided into two classes, single-phase and polyphase. Single-phase motors are of the induction and series types, and the polyphase motors are of the induction and synchronous types. Polyphase motors include both two-phase and three-phase machines. Motors of the induction type are provided with auto-starters or with variable secondary

resistance for starting. Synchronous motors are sometimes made self-starting, but more often they are provided with an induction motor for bringing them up to speed or are brought up to speed from some other source of motion through a clutch or belt. A compensator starter may also be used.

Single-phase motors are regularly made up to 15 horsepower, and in providing fuses and circuit-breaker, the size of the fuses should be such as to take care of the initial current, which is about twice the normal full-load current. In starting the single-phase motor, the double-throw switch on the starter is first thrown to the starting position, and after the motor has attained full speed the switch is thrown to the running position. (Fig. 148.)

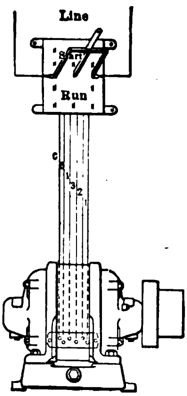


FIG. 148. — Wiring for starting single-phase induction motor.

On two-phase and three-phase circuits, induction motors are usually used. For large installations where 50 or more horsepower is required, synchronous motors are frequently used, as they diminish line disturbance and voltage fluctuations. The contractor seldom is required to install the synchronous motor, and if called on to connect up such a motor he should follow the manufacturer's instructions and diagrams.

The induction motor, when required to operate at a constant speed in a given direction, has many advantages over the direct-current motor. Its disadvantages are that the speed controller and reversing apparatus required for special work are complicated and expensive.

Induction motors of the squirrel-cage type are very simple and reliable, and have no commutators or brushes. An overload will tend to reduce the speed of the motor when it may drop out of step and stop.

In calculating the size of a motor to perform certain work, it is advisable to overload the induction motor slightly instead of underloading it. An induction motor runs with

a higher power-factor at a small overload, whereas the power-factor on underload is very low.

In deciding what type of induction motor to use, the conditions under which the motor is required to operate must be carefully considered.

Where motors are used in connection with a single machine and are frequently started and stopped, the auto-starter type will be found the most serviceable. This is due to the fact that even should the operator carelessly start the motor by throwing the switch over to the running position without going through the intermediate steps, no damage to the apparatus will result. Such procedure, however, should be rigorously discouraged.

In installations where the motor is started and stopped only once or twice a day by a careful attendant, the type of motor with an internal starting resistor should be used, as shown in Fig. 149. This type of motor draws less start-

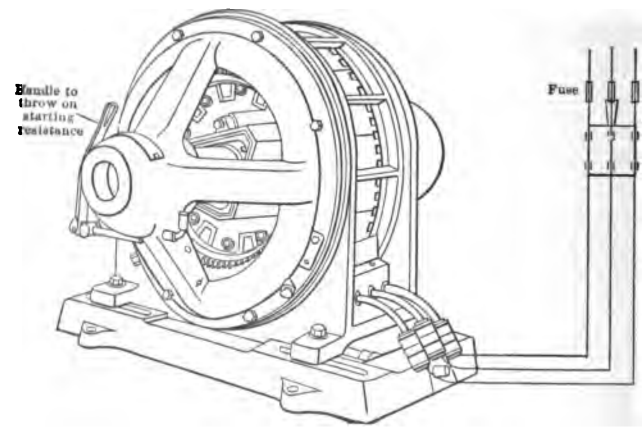


FIG. 149. — Induction motor started with resistance in the secondary.

ing current than the other type, and for that reason some electric light companies insist on an induction motor with self-contained resistor being used. The induction auto-starter motor frequently requires four to five times the normal

running current at starting. Table VIII gives the starting and full-load current of three-phase induction motors.

TABLE VIII. — CURRENT TAKEN BY THREE-PHASE INDUCTION MOTORS AT 110 VOLTS.[2]

Horse Power of Motor.	Full-Load Current.	Starting Current at 150 Per Cent of Full-Load Torque.	Starting Current at Full-Load Torque.
1	6.3	19	...
2	12	36	...
3	18	54	...
5	28	42[1]	28
10	54	70[1]	54
15	81	120[1]	81
20	112	167[1]	112
30	168	252[1]	168
50	268	400[1]	268
75	390	585[1]	390
100	5550	825[1]	550

[1] Equipped with auto-starters.

[2] On 220-volt circuits the current is approximately one-half of that given in the table.

The enormous difference which exists between the size of wires which would satisfactorily and safely carry current for operating an induction motor and the size of wires which would be required by a strict and narrow interpretation of the Code has been the cause of bitter argument many times between electrical inspectors and contractors. A wire of such size as to be protected properly by the large fuses required in starting is an unnecessary expense, and a fuse large enough to permit the motor to be started is no protection to the motor after it is running, as it would not blow on anything less than a short-circuit. It is customary, therefore, to provide two sets of fuses for induction motors requiring excessive current in starting; those on the starting side being larger than those on the running side of the switching circuit. In this way it is possible to start the induction motor without blowing the fuses, and after the motor is running it is properly protected by the smaller fuses. Oftentimes conditions of operation are such that the time

element of the fuses is sufficient to permit the motor to be started with smaller fuses, especially if the motor comes up to speed quickly. Motors taking less than full-load current when starting need only the running fuses. Fig. 150 illustrates 3-phase motor cut-out of this style.

Nearly all of the manufacturers of alternating-current motors supply starting devices also, together with complete

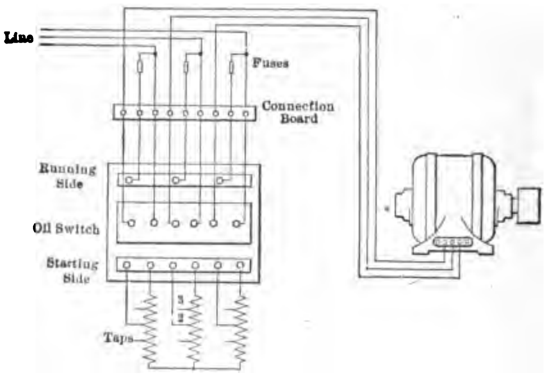


FIG. 150. — Induction motor started with a compensator.

instructions for connecting them in circuit. In motors rated less than 5 horsepower no auto-starters are required; the knife switch connects the motor directly with the line.

In wiring two-phase motors, three wires, as well as four wires, are used. If three wires are used, the third conductor should have approximately one and one-half times the sectional area of either of the other two. In four-wire, two-phase systems motors of one horsepower and under are usually of the single-phase type, and these are connected across one of the two phases of the system.

CHAPTER X.

INSTALLATION AND OPERATION OF DIRECT-CURRENT BELTED GENERATORS AND SWITCHBOARDS.

THE location of an electric generator has an important bearing on its operation. It must never be installed in a damp place, where a hazardous process is carried on, or where it would be exposed to flying combustible materials or inflammable gas.

A very important point is to locate the generator in as cool a place as possible, and where there is good ventilation. A generator running in a hot place will have a much smaller capacity owing to the limiting temperature rise.

Generators should be mounted on a good substantial foundation, insulated from the ground. Where it is impossible to insulate the frame, a ground wire should be run from the frame to a good ground connection. For small, belted generators, a drip pan must be placed under the generator similar to that required for motors, and illustrated in a previous chapter.

Direct-current generators, for general service, are either shunt or compound-wound. The latter should be generally used, so that in case of an additional generator being required, it will be possible to run them in multiple. This is not practical with a shunt machine.

In wiring for generators, it is a good plan to run a conduit down from the generator under the floor and come up at the rear of the switchboard. This makes a neat job and affords the wires good protection. If dampness is feared, use lead-encased cables; otherwise a good grade of rubber cable will do.

When compound-wound generators are operated in multiple, in order that the total load may be divided

between the machines in proportion to their several capacities, it is necessary that, in addition to the connections between the regular (+) and (−) terminals of the generators, a third connection between the machines be made at the points where the leads from the brush holders connect with the beginning of the series windings at the terminal blocks. The generators are therefore connected together at three distinct points. The lead from the beginning of the series winding is called the equalizer-wire, or equalizer, and is usually connected through a switch to the equalizing bus-bar on the switchboard, which is usually the middle one of the three bus-bars.

If the generators are of the same design and have the same rating, the only point which requires special attention in making the connections is to make sure that the connecting wires which run between the different machines are of the same size and length and therefore of the same resistance. This statement applies to the equalizer wire as well as to the main positive and negative leads. If, however, the generators differ in design or rating, the problem becomes more complicated. In such a case, the difference of potential or drop in voltage between that end of the series winding which is connected directly to one of the brushes, and the bus-bar to which the other end of the series winding is connected, should be exactly the same for every generator, when each is carrying its proper share of the load. To make this drop the same for each generator, it will often be necessary to increase the resistance in circuit with the series winding of the machines where the drop is least. The equalizer wire must have as little resistance as is practicable, and never more than the generator leads.

It sometimes takes several hours for the field winding of large machines to reach a constant temperature. As the machine heats up it is therefore necessary to decrease resistance of the shunt circuits to maintain the proper voltage.

Trouble is sometimes experienced in getting the load to

divide properly between two or more generators, for the reason that insufficient attention has been given to the matter of adjustment mentioned above.

If a generator, *A*, is connected to the line, and it is desired to connect in another generator, *B*, on the same circuit, bring *B* up to full speed; second, adjust the voltage of *B* as near to that of *A* as possible; third, close *B*'s circuit-breaker and then close the 3-pole switch; fourth, read the ammeters and see that the load is rightly proportioned between the two machines. If *A* is doing more than its share of work, decrease its voltage by increasing the resistance in the circuit with its regulator; or decrease the resistance in the circuit with *B*'s regulator. If *B* is doing too much work, throw the regulators in the opposite direction.

If desired to connect in a third, fourth, or fifth machine, follow the same instructions.

If one generator is connected in multiple with another when its voltage is less than that of the first, it will not take its share of the load and may therefore run as a motor, the first generator supplying the energy. In such a case, decrease the resistance with the regulator of the machine which has just been connected in the circuit.

When two machines are working together, if the belt on one of them should break or slip off, this machine will continue to run, being driven as a motor by the other.

If it is found that the machines do not operate together satisfactorily, note the position of the brushes. If one machine carries too much of the load, move its brushes slightly forward; if too little, slightly backward, being careful not to cause them to spark.

If it becomes necessary to raise or lower the voltage of the line, raise or lower the voltage of all generators connected to it.

In stopping a generator, first, increase the resistance with the regulator of the generator to be disconnected until its load is very small, as shown by the ammeter. Second, open the 3-pole switch of the generator to be disconnected. Third, stop the prime mover, or release

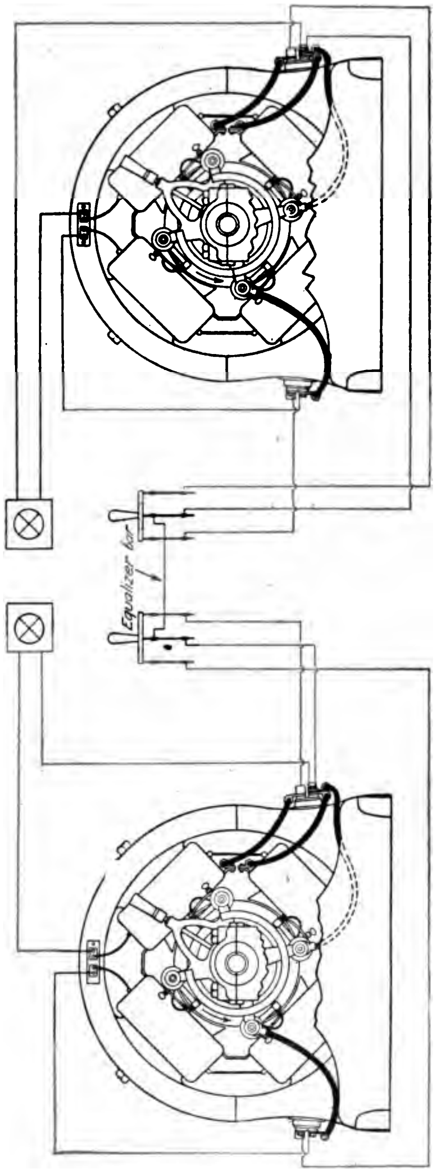


Fig. 151. Wiring diagram of two compound generators connected in parallel.

the friction clutch. Wipe off all oil or dirt and put the generator in order for the next start.

Fig. 151 gives wiring diagram of two compound-wound generators connected in multiple.

Sometimes in starting a new generator it will fail to excite itself, and consequently to generate no e.m.f.

If upon starting the generator, it fails to show any voltage when running at normal speed, examine the field circuit to see if it is not broken by an open switch, poor connection, or burnt-out rheostat. A magneto machine may be used to test the field circuit, but it is possible that the machine will not ring through the high resistance of the whole field. In this case, sections of the field winding may be taken, say one pole at a time, going completely around the field. If the field and armature circuits are intact, the fault may be due to a reversed connection. If this is so it can be shown very simply by opening the field circuit. If the voltage rises slightly and then falls again upon closing the circuit, it is pretty certain that the residual field-magnetism is opposed by the ampere-turns of the shunt-field circuit, and the connections of the latter are wrong. Reverse the shunt-field circuit connections and the generator should not give further trouble.

It may, however, be necessary to separately excite the generator from some other source. Calling the generator it is desired to excite, No. 1, and the other machine from which is to serve as exciter, No. 2, the following procedure should be followed: Open all switches and remove all brushes from generator No. 1; connect the positive brush-holder, No. 1, with the positive brush-holder of No. 2, and also connect the negative brush-holders together. It is also desirable to connect a 5-ampere fuse in the circuit. Close the circuit. If the shunt winding of generator No. 1 is all right, its field will show considerable magnetism. If possible, reduce the voltage of generator No. 2 before opening the circuit. If this cannot be done, increase the resistance in the field circuit of No. 1 to the limit and then open the connections slowly.

If it is impossible to obtain a second generator, this excitation may be accomplished with a strong battery by con necting the carbon or copper plate of the battery to the

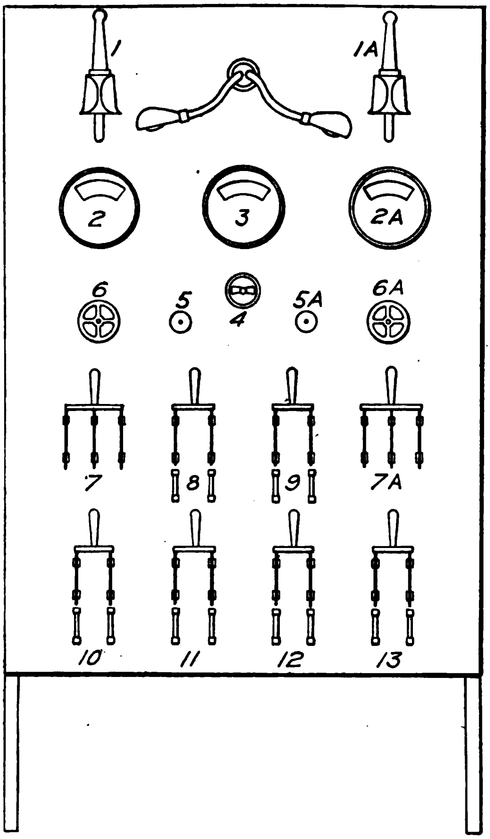


FIG. 152. — Switchboard for connecting two compound-wound generators in parallel.

1–1*A*. Circuit-breakers.
2–2*A*. Ammeters.
3. Voltmeter.
4. Voltmeter switch.
5–5*A*. Ground detector lamps.
6–6*A*. Rheostat handles.
7–7*A*. Generator switches.
8–13. Circuit switches.

positive brush-holder of the generator and the other plate to the negative brush-holder.

In running belted compound generators in multiple, care

must be taken to keep the belts taut, so that the speed of the machines remains constant. Excessive slippage of a belt will affect the voltage and tend to unbalance the load.

Generators should have a name plate giving full data, and be provided with a waterproof cover when not in use.

Switchboards should be made of slate or marble, upon which should be mounted all appliances necessary for the proper control of the generator.

The connections should be made by pure copper bus-bars figured on the basis of carrying 1000 amperes per square inch. The switches should be of substantial make, having contacts figured at the rate of 75 amperes per square inch of surface. The switches should have two sets of clips for each circuit. The fulcrum of the switch should not be used as a contact, as it frequently loosens and consequently gets very hot.

Circuit-breakers should be used instead of fuses. If fuses are used, the enclosed type should be selected. Open-link fuses, when blown, disfigure the face of the board.

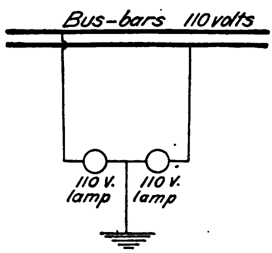


FIG. 153. — Ground detector.

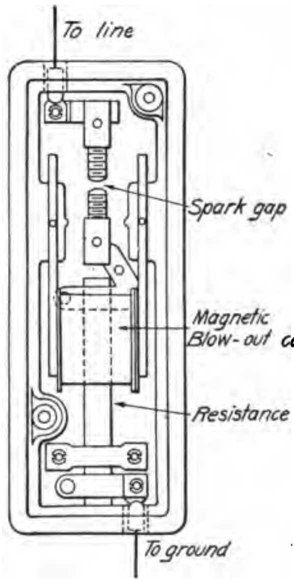


FIG. 154. — Lightning arrester.

Switchboards should not be built down to the floor, and should be open in the rear at least two feet from the wall.

The instruments should be high grade, dead beat, not easily affected by exterior magnetism. The ammeter should be of a type using a shunt, which shunt can be neatly connected in the main circuit, and having small leads running to the instrument. The field rheostats controlling the generator should be mounted on the back of the board and be controlled by a handle on the front.

Fig. 152 illustrates a good type of board for connecting two compound-wound generators in multiple. Only one voltmeter in connection with a voltmeter switch is required. This switch enables the voltmeter to be thrown on either generator.

A ground detector is also required. A good and simple form of ground detector is made by connecting two lamps in series, as shown in Fig. 153. A ground on one side of the system will tend to make one of the lamps burn to full candlepower, whereas if there is no ground, the lamps, being in series, will burn dimly.

There should be additional circuit switches provided over original requirements. If there are motors on the line, a switch controlling the motor circuit should be on the board.

Where there are outdoor circuits of any length, lightning arresters will be found necessary. The lightning arresters should be mounted on a fireproof support and securely grounded in a manner described in a previous chapter. Fig. 154 illustrates a good type of arrester.

CHAPTER XI.

ELECTRIC SIGNALS AND TELEPHONE SYSTEMS.

To properly install electric signals and telephones requires great care and attention to details. The materials should be of the best, and perfect installation is an important factor. As systems of this class are usually put in under a year's guarantee, careless installation proves to be expensive for the contractor and annoying to the customer.

The quality of the wire used and the manner of installing it are of great importance. Rubber-covered wires are recommended for all classes of work. For open wiring in dry places, weatherproof or damp-proof office wire can be used.

In running signal wires in fireproof buildings, or in groups, they should be drawn through iron conduits. A good plan in this connection is to install a number of distributing centers, such as illustrated in Fig. 155. These centers make it convenient to test out, or run additional circuits from. For all large signaling systems, these distribution centers are recommended. All terminals should be numbered. If additional signals are subsequently installed, the circuits can be run from the nearest centers as illustrated in Fig. 155.

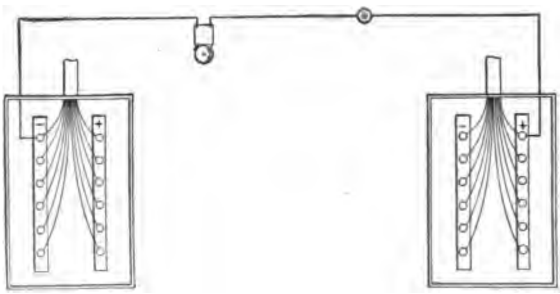
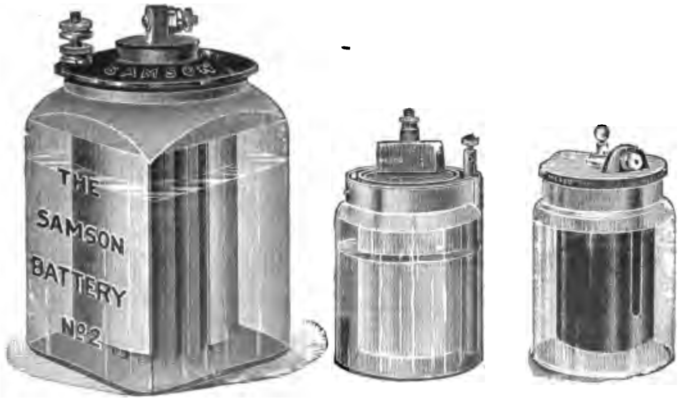


FIG. 155. — Distributing centers.

For open wiring use porcelain insulators and avoid fastening wires with staples as much as possible.

The selection of the proper batteries is important. For open-circuit work in small systems, dry cells of good quality can be used. When buying dry cells insist on getting fresh ones, and do not lay in a large stock. Dry cells deteriorate even when not used, due to an oxide forming on the inner surface of the zinc, and the drying of the chemicals. To test a dry cell use an ammeter, connecting it directly across the terminals. Make a momentary contact only, in getting a reading. Good fresh cells should not produce less than 20 amperes on short-circuit. When cells produce less than 7 amperes they should be replaced. The voltage should be 1.5. Dry cells should be installed in a cool place, though care should be taken that they do not freeze.



FIGS. 156, 157, and 158. — Open-circuit cells.

Good types of wet open-circuit cells are illustrated in Figs. 156 to 158. Where large values of current are required, cells having low internal resistance, such as illustrated in Fig. 156, should be used.

When installing wet cells of this class, see that the zincs are thoroughly amalgamated. This is of great importance for the following reasons: Commercial zinc contains iron. If this iron is exposed to the salammoniac solution, local action between it and the zinc takes place. This action

sets up innumerable small cells which work to deteriorate the battery. By covering the zincs with mercury the local action is minimized.

In large signal systems open-circuit cells are inadequate, and storage batteries or small motor-generators should be

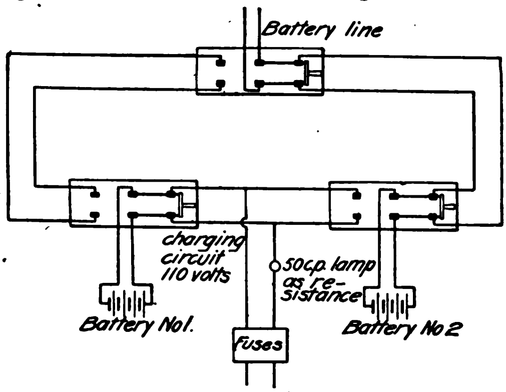


Fig. 159. — Connections for a storage-battery charging panel.

used. Fig. 159 shows the connections for a storage-battery charging panel, there being two batteries of four cells each connected to the board.

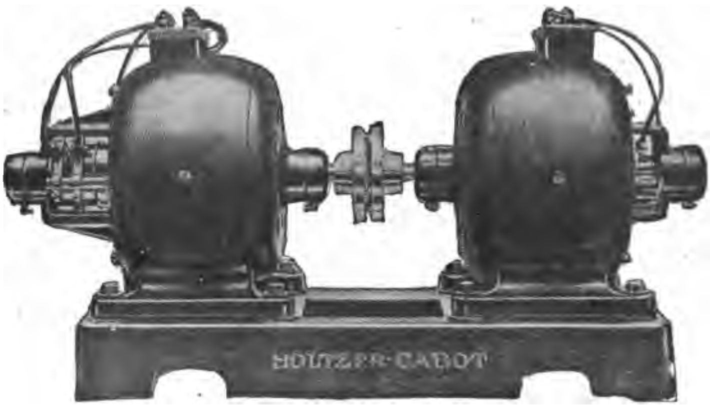


Fig. 160. — Motor-generator set.

Fig. 160 illustrates a $\frac{1}{8}$-horse power motor-generator set which is well suited to the requirements of a signaling

system. When a motor-generator set is used, provision must be made for maintaining the service in case the motor-generator is shut down. This provision may be made by installing either a duplicate motor-generator set or a group of open-circuit cells.

In ordering a motor generator, it is advisable to have it wound for not less than 15 volts, and then reduce this voltage by varying resistance in the main circuit. This is advised for the reason that it is difficult to obtain satisfactory results from a very low voltage generator, due to poor contacts at the brushes.

Do not use conductors which are too small. Owing to the low voltage used, the drop in potential is considerable, and the use of too small wire will materially affect the efficiency of the system.

For certain classes of work, such as fire and burglar-alarm systems, closed-circuit cells must be employed. The type of closed circuit cell most generally used is the "Gravity" or "Crowfoot," as it is often called, shown in Fig. 161. This cell has zinc and copper elements, and has, as an electrotype, a solution of "blue vitriol." This battery is at its maximum efficiency when the blue solution is halfway up the jar, the balance of the solution being white, from the sulphate of zinc formed by chemical action. To hasten this condition of the solution, when a battery is first set up, put in a small quantity of sulphate of zinc, and short-circuit the battery.

Fig. 161.—"Crow-foot" cell.

To obtain good service from bluestone cells they must always be kept on a closed circuit. Therefore, when turning off the cells from a signal system, connect them to a resistor by means of a two-point switch as illustrated in Fig. 162.

Signaling systems are divided into various classes as follows: electric-bell systems, annunciator systems, burglar-alarm systems, fire-alarm systems, watchmen's clocks, and telephone systems.

In all electric signaling systems a very important feature is contact. Through poor contacts, a system otherwise per-

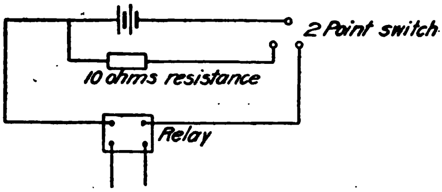


FIG. 162. — Connections for closed-circuit cells.

fect, will cause trouble. All wire joints should be soldered, otherwise corrosion sets in, which will often cause an open-circuit that is difficult to locate.

In electric-bell circuits, the pushbuttons, especially if in a damp place, or outdoors, should have platinum-tipped contacts. This applies also to vibrating bells, as the arc will easily burn through any other metal. In selecting the type of button to use, the style will depend on the location.

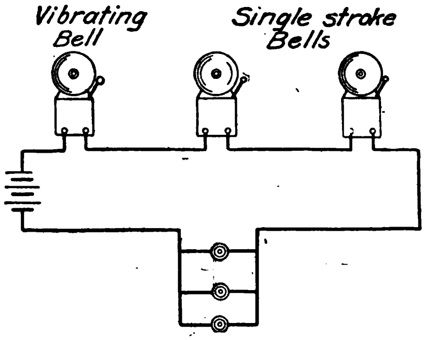


FIG. 163.—Three bells operated by three pushes.

For front-door or outdoor work, bronze buttons with a screw-cap will be found most serviceable. For interior work, neatness and appearance should govern the choice. The desk pushbutton is very popular, as it is easily installed by simply boring a hole and snapping it in place. In return-call systems the double-contact button is used. The style

of bell or signal to use depends on the service. In private houses, where a number of bells are usually grouped, bells of various tones are used. Buzzers are also very popular.

A good suggestion for the butler's call is to use a small bell — made single stroke — which is connected to a floor

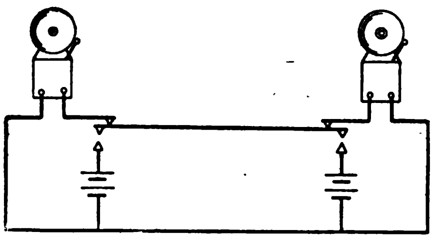


FIG. 164.—Two pushes operating two bells.

push. Such a call is only audible to the servant, a feature much desired in this class of work.

The size of gong to use depends on the work, and the contractor should select only bells of best quality.

In flat houses, door-openers are set in the door jamb.

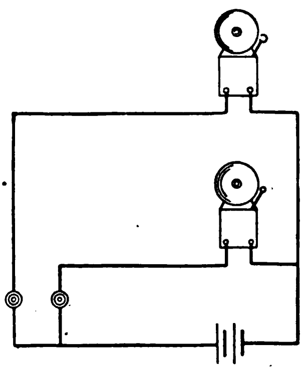


FIG. 165.—Return call using three-point button; two sets of call-lines, two wires.

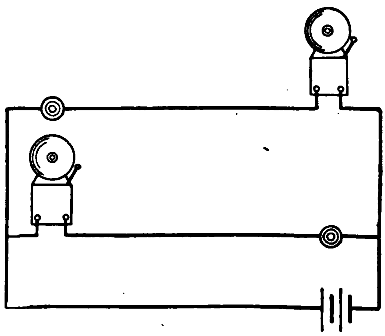


FIG. 166.—Return call; three wires; one set of batteries.

When the circuit is closed the nose-piece is released, allowing the door to be opened.

Figs. 163, 164, 165 and 166 give a number of bell-circuit diagrams. Annunciators are of two classes: needle, as

illustrated in Fig. 167, and gravity drop, as shown in Fig. 168. Needle annunciators, owing to their neat appearance,

FIG. 167.—Needle annunciator.

FIG. 168.—Gravity drop annunciator.

are most generally used. They are also made self-restoring, so that the last call only is registered, the previous call being automatically reset.

When installing an annunciator system in offices, the wires should be run in cables. These cables should be made up of various colored wires, so as to facilitate testing and connecting. A few spare wires should always be put in to provide for additions or breaks. Fig. 169 gives diagram of regular annunciator system. The wiring of elevator-call systems requires a special flexible cable running from the car to the middle of the shaft. The ends of the cable should be connected to the circuit wires through a terminal block. The cable should be made of conductors composed of fine cop-

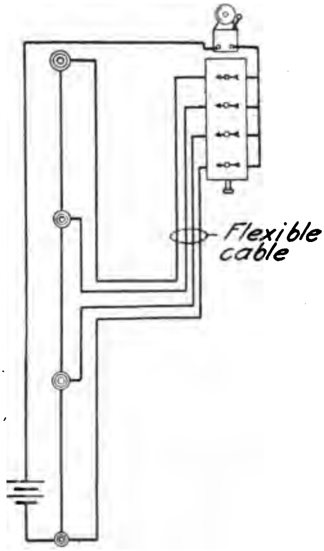
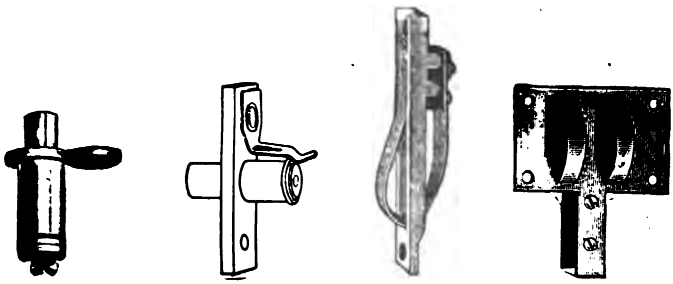


FIG. 169.—Annunciator system.

per wires, so as to be very flexible, otherwise the cable will easily kink and consequently break the wires.

Burglar-alarm systems are of two classes: open-circuit and closed-circuit. In open-circuit systems, should an open circuit occur, or the wires be cut, the system will be dead. In a closed-circuit system any break in the circuit rings the alarm.

Open-circuit systems are generally installed in private houses. The usual practice is to place circuit-closing springs in the window frames and door jambs. Figs. 170



FIGS. 170, 171, 172 and 173. — Door and window springs.

to 173 illustrate a number of door and window springs. When cutting in window springs care must be taken that the sash fits the frame snugly, otherwise the springs will make contact, even when the windows are closed. Fig. 174 illustrates a simple open-circuit burglar-alarm circuit. A constant-ringing drop is placed in the circuit as shown. This device is necessary to prolong the duration of the signal, otherwise a door or window could be opened and closed quickly, making only a momentary call which may not be heard.

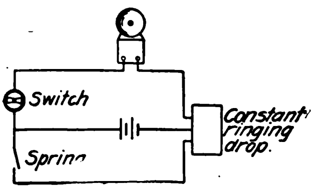


FIG. 174. — Open-circuit burglar-alarm system.

A burglar-alarm instrument which is a modification of the regular annunciator is shown in Fig. 175. This instrument has a number of attachments to round out the system.

Each circuit is controlled by a separate switch. The constant ringer is in the case, and can be cut out by a switch. Switches for making silent and battery tests are also provided. A clock is connected to the circuit, so as to cut out the entire system at a predetermined time. This is so arranged to enable the servants to open the house without setting off the alarm.

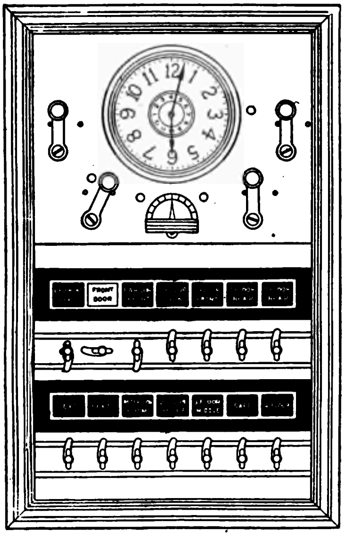


FIG. 175. — Burglar-alarm clock.

Fig. 176 illustrates a Yale-lock switch which is connected in the main circuit of the burglar-alarm system. This lock is placed at the entrance door, so that anyone with a key can temporarily disconnect the alarm while entering the house. This arrangement enables the alarm to be set irrespective of late arrivals.

Closed-circuit burglar-alarm systems are usually installed in factories and stores. The circuits are run in series. No. 24 bare copper wire is frequently used for this purpose. Screens in which a bare copper-wire circuit is imbedded are often used to protect doors, windows and vaults. All connections must be of the closed-circuit type and run in series with a relay and a closed-circuit battery, as illustrated in diagram Fig. 177. The signal bell is often mounted in the front of the building and should have at least a 10-inch gong and be weatherproof. Care must be taken to keep the gravity cells in good order by

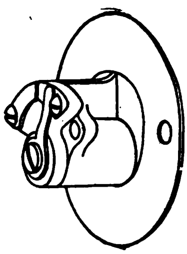


FIG. 176. — Yale lock switch.

keeping them constantly on closed circuit as previously explained.

Watchman clocks are a modified form of annunciator, in which the call punches a record on a dial. Watchman clocks are of two classes, those using a battery and those using small magneto generators to call with. The latter are preferred as they eliminate battery troubles and renewals.

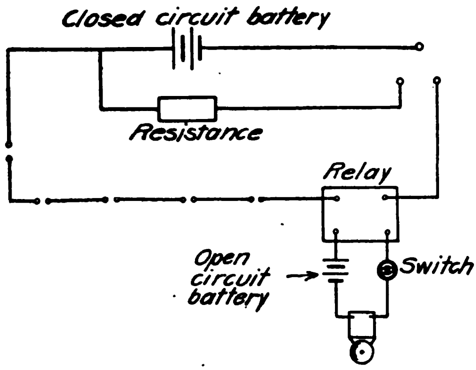


FIG. 177. — Closed-circuit burglar-alarm system.

The battery type of clock is operated by inserting a key into a special form of switchbox, one of which is located at each station that the watchman is expected to visit. In the magneto type this switchbox is replaced by a small box containing a magneto generator, and the watchman is required to turn the crank that projects through the side of the box.

The wiring of both systems is similar to that of the regular annunciator system shown in Fig. 169, except that in the magneto system no batteries are used.

Fire-alarm systems for local or private use are of two general classes, open-circuit and closed-curcuit. For signaling, either pushbuttons or automatic thermostatic devices are used. For use in connection with open-circuit fire alarms a special thermostatic cable is made. This cable is made up of wires which fuse at a certain temperature, and, by fusing, close the circuit. Consequently every inch of the wire is a fire alarm.

Fig. 178 illustrates a good type of fire alarm. The batteries, bell, and a constant-ringing drop are all in one case having two terminals. To these terminals any number of

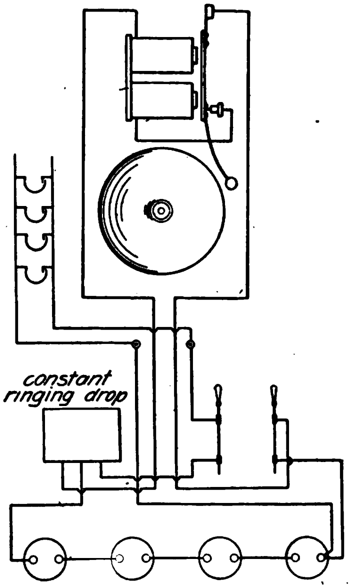


FIG. 178. — Fire-alarm system.

open-circuit call devices or thermostats can be connected in multiple. When an alarm is sounded the bell will continue to ring until turned off.

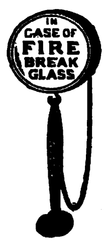


FIG. 179.— Fire-alarm call.

Fig. 179 illustrates a good type of fire-alarm call to use. They can be obtained for either open- or closed-circuit work. In all open-circuit systems, frequent tests of the alarm are very necessary, as an open-circuit might put the whole system out of order.

Closed-circuit fire-alarm systems are wired in a manner similar to closed-circuit burglar-alarm systems, excepting that thermostats and calls are in series with the battery and relay in place of screens and springs. Or closed-circuit gongs can be used, which

dispense with the relay and secondary circuit. Such a gong is wired as shown in Fig. 180.

Installing telephone systems has become a very important part of the contractor's business. Good, careful work is very essential. Nothing "sours" a customer quicker than a telephone system constantly out of order.

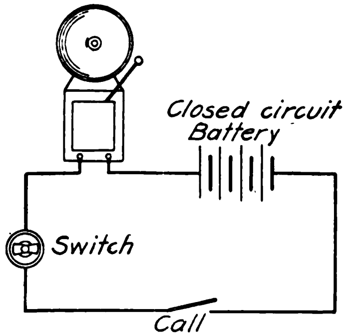


FIG. 180. — Closed-circuit fire-alarm system.

To start with, the instruments should be of good substantial make, purchased direct from a reliable manufacturer. Quality, not price, should be the deciding factor.

For short, private lines, with a central telephone calling two or three others, a good type of battery telephone is illustrated in Fig. 181. The wiring diagram in Fig. 182 shows that a talking and ringing battery are used. Three wires are run to each instrument. The connections are simple to make, as all terminals on the instrument are plainly marked.

FIG. 181.—Wall telephone for apartment houses.

The intercommunicating system is the most popular. It allows of simultaneous communication between a number of different stations, and if properly installed is a valuable adjunct to any business. A talking and ringing battery is installed in a central place; no local batteries should be used.

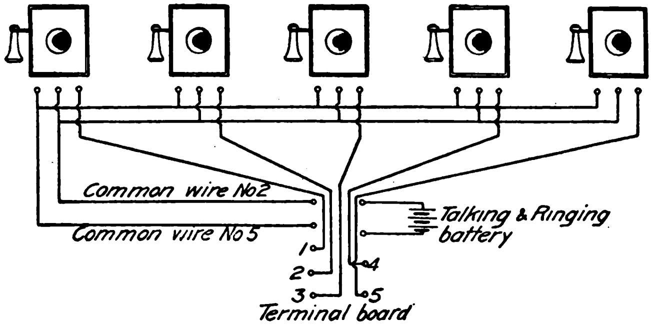


FIG. 182. — Wiring diagram for private line.

Fig. 183 illustrates a good type of intercommunicating desk instrument, and Fig. 184 a wall type. The call board

FIG. 183. — Intercommunicating telephone, desk type.

FIG. 184.— Intercommunicating telephone, wall type.

should be of the self-restoring type. Fig. 185 shows wiring diagram of a standard type of intercommunicating system.

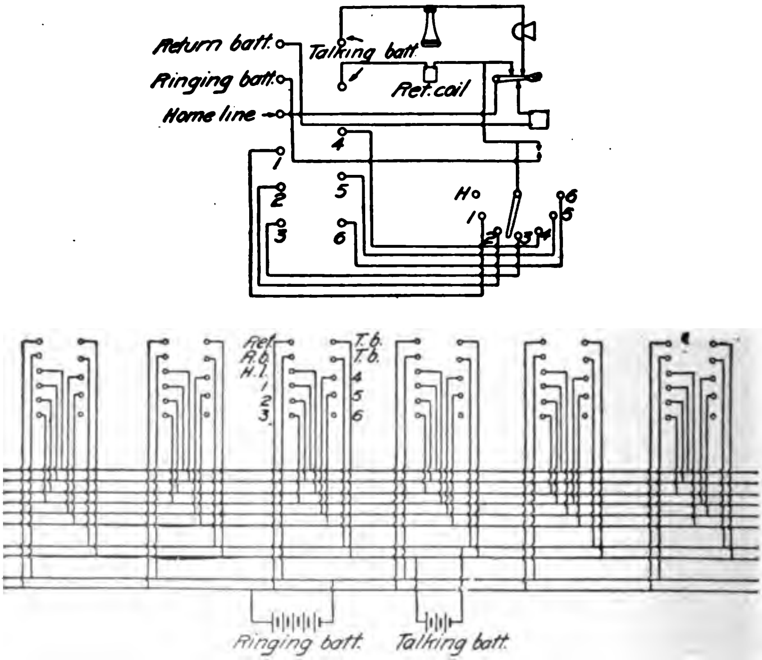


Fig. 185. — Wiring diagram of intercommunicating system

 Fig. 186. — Switchboard.

Always put in a few spare pairs when wiring for a telephone system. This makes the adding of more stations inexpensive. Also use instruments with more stations than originally required; otherwise, if additional telephones are wanted, all the instruments will have to be replaced.

Fig. 187. — Magneto telephone.

Where fourteen or more telephones are required, the central switchboard system is desirable. What is known as the central-energy type is the best, as all batteries are centralized. Fig. 186 illustrates a good type of switchboard to use. Self-restoring drops are the best, as they minimize the operator's duties and avoid confusion. In switchboard system magneto calls, as illustrated in Fig. 187, can be used in place of battery cells. They are somewhat more reliable and more expensive.

In large systems use storage batteries and motor generators in place of wet or dry cells. This will add much to the efficiency and reliability of the system.

Electric gas-lighting work, owing to the many chances of "grounds," must be very carefully installed. The use of

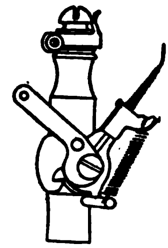


FIG. 188. — Pull burner.

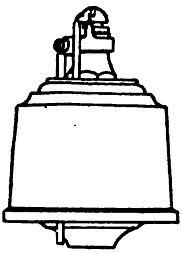


FIG. 189. — Automatic burner.

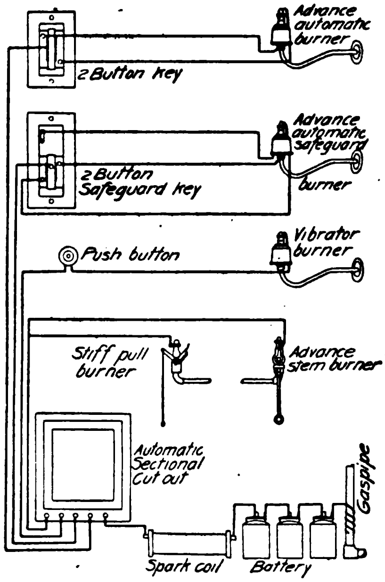


FIG. 190. — Wiring diagram of gas-lighting system.

the gas pipe as a return, though logical and cheap, should be discouraged. The burners should be insulated from the gas fixture by rubber nipples. The batteries should be a good open-circuit type, preferably those illustrated in Fig. 156. No less than six cells should be used. A spark coil is required to increase the intensity of the spark. Fine silk wires of color to match the fixtures are used for fixture wiring. They should be shellacked to the fixture so as to be as inconspicuous as possible. The fixture should be insulated from the gas pipe by an insulating joint. Fig. 188 illustrates a type of pull-burner. Fig. 189 shows an auto-

matic burner, in which the gas valve is opened and shut by small magnets. Fig. 190 gives wiring diagrams of gas-lighting system with a grounded return.

No gas-lighting system is complete without a cut-off, the function of which is to cut out a circuit on which there

FIG. 191. — Automatic cut-out.

is a short-circuit or ground. This saves the battery and allows the rest of the system to operate properly. (See Fig. 191.)

CHAPTER XII.

SPECIAL LIGHTING DEVICES.

A VERY profitable department can be created if special illuminating devices are properly exploited. For many years lighting appliances have been installed in a haphazard manner with no regard to operating cost and efficiency. The contractor, by suggesting more efficient lighting fixtures and rearrangement of lighting systems, can readily make a good margin of profit and at the same time reduce his customers' operating expenses.

The regular carbon filament lamp has a specific consumption of about 3.1 watts per candlepower. The later type of metallized filament lamps have a specific consumption of about two watts per candlepower, and that of the Tungsten lamp is about 1.2 watts per candlepower. It is apparent that under proper conditions the use of more efficient lamps is far more economical than the regular type. The initial cost of the high-efficiency lamps does not materially affect this saving, as will be seen by the following data:

TABLE IX.

Initial cost of ordinary lamp (16 cp.)	$.16
Cost to burn 1000 hr. at 10 cents per kw.-hr.	5.00
Total cost to burn lamp	$5.16
Initial cost of Tungsten lamp (36 cp.)	$1.50
Cost to burn 1000 hr. at 10 cents per kw-hr.	4.00
Total cost to burn lamp	$5.50

From this it is seen that a 36-candlepower lamp of one type can be operated at a cost which but slightly exceeds that of operating a 16-candlepower lamp of a less efficient type.

The disadvantage of the Tungsten lamps lies in the fact that the filaments are very fragile, and the breakage is therefore considerable. Owing to these fragile filaments the lamps must hang in a downward position, which naturally limits their use. Another factor tending to discourage the use of high priced lamps is the fact that inasmuch as the cheaper types of earlier filament lamps are frequently stolen, the high priced ones of course are not exempt.

There has been put on the market a socket, illustrated in Fig. 192, in which the threaded shell swivels. This shell is locked with a key, in order to renew a lamp, otherwise the lamp and shell turn freely, making it impossible to unscrew the lamp from its socket.

Fig. 192. — Lock socket.

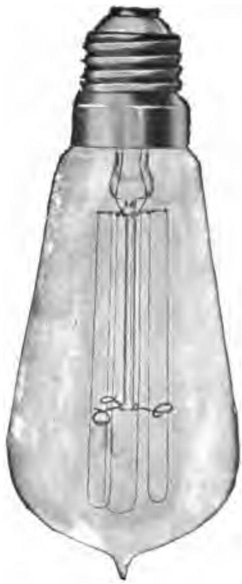


Fig. 193. — Tungsten lamp.

By rearranging a lighting system so as to use the Tungsten lamp to its fullest advantage a considerable saving in energy is effected. Fig. 193 illustrates one of the several types of Tungsten lamps. The graphitized filament lamp (often erroneously called metallized), shown in Fig. 194 in connection with a holophane reflector, is a very good type of lamp for store lighting. This appearance is such as to lend itself to decorative work, and in clusters makes a very efficient and handsome fixture. Figs. 195 and 196 illustrate two types of clusters — very popular and efficient.

Fig. 197 illustrates another type of high efficiency lamp —the Nernst. The specific consumption of this lamp is half that of the carbon filament lamp. The Nernst lamp has as a light-giving element, called a glower, a small

porcelain-like rod which when cool is a non-conductor. This rod becomes a conductor when hot and emits a white light of about 40 candlepower. A small spool wound with platinum wire acts as heater, and is automatically cut out when

Fig. 194. — Graphitized filament lamp.

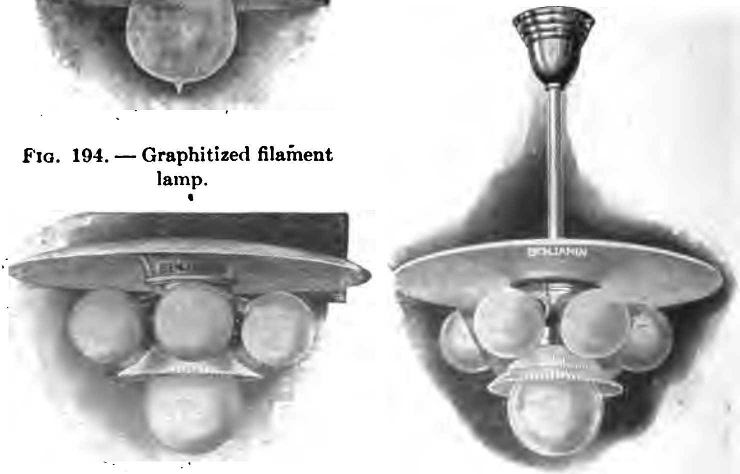


Fig. 195. — Lamp clusters.

the glower is hot. The Nernst lamp is made in several sizes, having one or more glowers.

The average life of a glower operating on a direct-current system is only about 400 hours, whereas 700 hours is the average with alternating current. To maintain the Nernst lamp expert attendance is required and the contractor should make a maintenance contract with his customer. The Nernst lamp compares very favorably with other types of lamps in reasonable maintenance cost.

Fig. 198 illustrates a type of mercury-vapor lamp. This lamp has a specific consumption of about 0.6 watts per candlepower. It is made in 300- and 700-candlepower

sizes, for both direct and alternating current. Owing to the absence of the red rays, color values are destroyed and

FIG. 196. — Cluster lamp sockets.

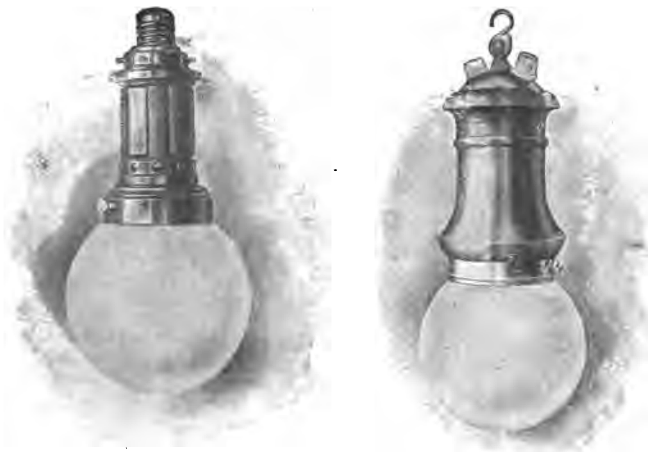


FIG. 197. — Nernst lamp.

the light is only useful for general lighting of large areas, or for draughting rooms, pressrooms, and factories, where the color value makes no difference.

The quality of the light is well suited for draughting rooms or similar places, as the eyesight is not so easily strained under this light as under other forms of artificial light.

Another field for the mercury-vapor lamp is in photographic and photo-engraving work. Its actinic qualities

FIG. 198. — Mercury vapor lamp.

are very good, and it is far more efficient than the open arc for this class of work. Fig. 199 illustrates a photo-engraving type of mercury-vapor lamp.

One of the latest developments in the lighting field is the flaming arc, illustrated in Fig. 200. The flaming arc has a specific consumption equal to about one-fifth that of the enclosed arc, producing about 2200 mean hemispherical candle-power with a consumption of about 550 watts.

The flaming arc owes its high efficiency to the carbons, one of which has a core impregnated with metallic salts. The color of the light can be varied by using different salts.

FIG. 199. — Photo-engravers lamp.

FIG. 200. — Flaming-arc lamp.

The standard color is golden yellow, which gives the greatest efficiency. Brilliant white and pearl white are used for inside lighting, and the former for photographic work. The efficiency of the white flaming arc is considerably below the golden yellow, being more comparable with that of the open arc.

The carbons of the flaming arc converge downwardly, which naturally makes the mechanism considerably different from the open arc or enclosed arc. The flame across the crater of the two carbons is controlled by a magnetic

field which bows out the flame as illustrated in Fig. 201. This magnet also assists in regulating the lamp. If the arc shortens, the current will naturally increase. This strengthens the field which is produced by current in a winding connected in series with the arc, blowing the flame downward in a longer bow, which increases the length of arc, and naturally decreases the current.

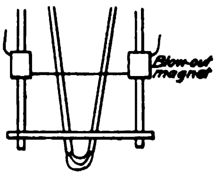


FIG. 201. — Diagram of flaming-arc lamp.

The flaming-arc lamp has a voltage of about 44 at the arc and 55 at the terminals. Consequently two lamps should be connected in series on 110-volt circuits. This, together with the fact that the carbons consume about 1 inch per hour and are expensive, has prevented its more general use.

For exterior lighting, or for lighting docks, sheds, and large mills, the flaming arc as an artificial illuminant is far superior to any other form of lighting. Owing to its great initial candlepower and light penetrating qualities it can be hung high, thus illuminating in a satisfactory manner a large area.

The carbons are made with a wire conductor as, owing to their length, the resistance is considerable. It was found

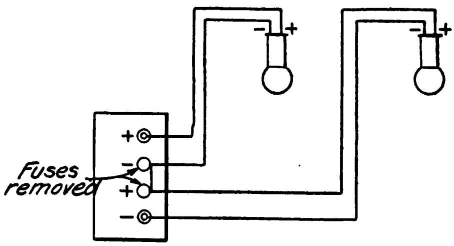


FIG. 202. — Arrangement for connecting arc lamps in series.

necessary to reduce this resistance so as to obtain good regulation and uniform current during the entire run. The direct-current lamp runs best at 10 amperes and the alternating best at 12 amperes.

The carbons give off considerable vapors and ash, which should not be permitted to penetrate the mechanism of the lamp.

When installing a pair of direct-current flaming arcs in place of two enclosed arcs, first test the polarity at terminals. If the cut-outs for the two arcs are in one cabinet, the two lamps can be easily connected in series by putting a jumper across as illustrated in Fig. 202. When running circuits for flaming arcs the size of wire should not be less than No. 12 B. and S. gauge.

Flaming arcs should be hung as high as possible and this together with the fact that they must be frequently trimmed makes a lowering device necessary.

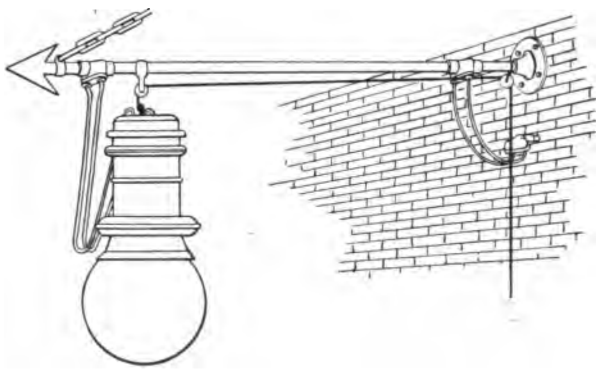


FIG. 203. — Arc-lamp wiring.

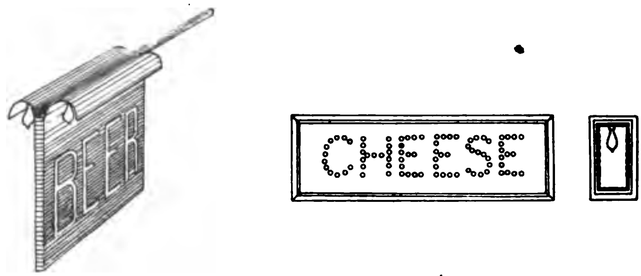
Flexible conductors should be run from the lamp terminals to the circuit wire as illustrated in Fig. 203.

Electrical Signs.

The manufacture of electrical signs has become a specialty: nevertheless, the contractor is frequently called to install them.

Electric signs are of two classes, those signs in which the lamps outline the characters and those in which the light is simply used to illuminate a transparent or a painted sign.

Figs. 204, 205, 206 and 207 illustrate a number of typical signs. The installation of wiring of this class requires only compliance with the rules for outdoor wiring.



Figs. 204 and 205. — Typical signs.

Lamps required for outlining characters should be of low candlepower and if letters are closely spaced should be

Fig. 206. — Typical sign.

frosted. Four and eight candlepower lamps are the best to use, as lamps of higher candlepower tend to blur the characters, owing to too much diffusion. At the same time

the operating expense is much reduced. For large signs, especially those erected on walls and tops of buildings, a good plan is to use a lamp having a higher voltage than the circuit.

FIG. 207. — Typical signs.

This reduces the glare, makes the characters more distinct, and at the same time saves the cost of renewals and time of replacing burnt out lamps.

Flashing devices, consisting of a commutator switch, run by a motor as illustrated in Fig. 208, are important acces-

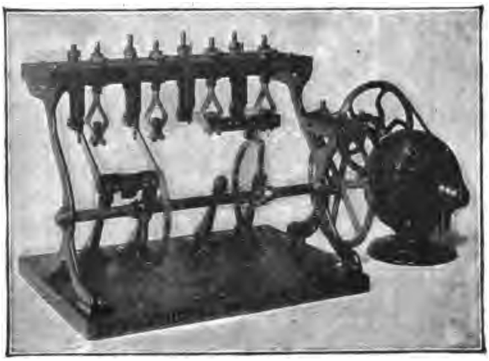


FIG. 208. — Flasher.

sories for increasing the advertising value of signs. The operating cost is also greatly reduced, as many of the lamps are only flashed a few seconds every minute.

The flasher must be enclosed in a fireproof case and the

contacts should be frequently cleaned. Many startling effects can be produced with the flasher, as the combinations are limitless. Fig. 209 illustrates a sign in which the letters are flashed successively so as to spell out the whole word which is finally flashed.

Fig. 209. — Flash sign.

There are a number of special sign sockets made which are weatherproof and easily connected. Fig. 210 illustrates a good type. In connecting up signs each letter should form a separate circuit and on borders or outlines, the circuit should not exceed 660 watts.

Fig. 211 illustrates a good type of clock switch which is used to automatically turn on and off a circuit at a pre-

Fig. 210. — Sign socket.

Fig. 211. — Clock switch.

determined time. These switches are frequently used to control signs and window lamps.

Special Electrical Devices.

The contractor can readily increase his profits by selling to his trade the latest electrical devices. The margin of

Fig. 212. — Flat iron.

Fig. 213. — Heating pad.

profit is good and in addition to the profit on the sale of the device, a substantial profit is made on the installing of the same.

For private house use Chapter VII calls attention to a number of "extras." Electric heating apparatus, owing to their neatness and convenience, offers a good field to the

FIG. 214. — Chafing dish.

contractor. When wiring a house it is wise to include a heating circuit. This circuit should run from the panel to the butler's pantry. A 25- or 50-ampere fused knife switch should be placed on the panelboard to control this circuit.

FIG. 215. — Curling iron heater.

Figs. 212, 213, 214 and 215 illustrate a few of the many heating devices for household use. The attaching plugs should be the separable swivel type.

FIG. 216. — Ice plant.

Motor-driven household apparatus includes fans, ventilators, polishers, sewing machine motors and for large establishments small ice machines. Fig. 216 illustrates an automatic ice plant suitable for this class of work, as well as for small hotels, butcher shops, etc.

FIG. 217. — X-ray outfit.

In wiring a doctor's or dentist's office always install a number of flush receptacles. Also put in a 25-ampere circuit for X-ray work. Fig. 217 illustrates one of the many electrical devices which can be sold to this class of trade.

The retail stores of all classes is another field open for the enterprising contractor to introduce specialties.

Fig. 218. — Hair drier.

Fig. 218 illustrates a hair drier for hair-dressing establishments. Fig. 219 shows an electric massage device for barber shops.

Fig. 219. — Vibrator.

Fig. 220 shows a small compressor plant suitable for dentists, doctors and barber shops. Fig. 221 shows a beer pump which is automatic in operation.

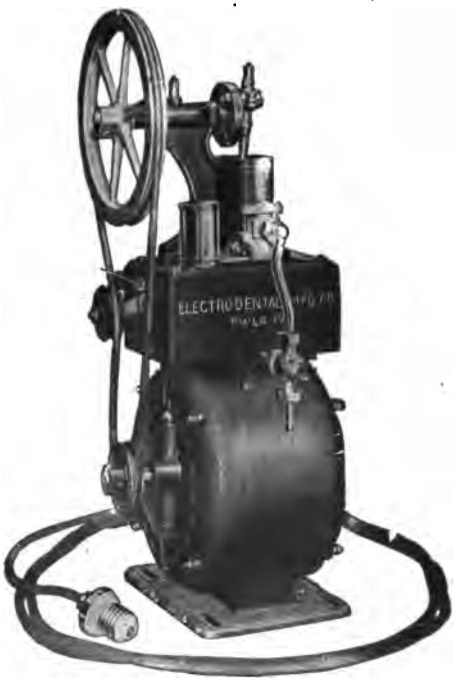


Fig. 220. — Air compressor.

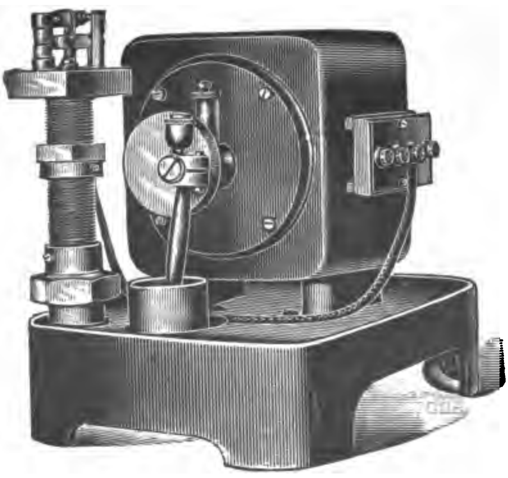


Fig. 221. — Beer pump.

Grocery stores can use coffee grinders, as illustrated in Fig. 222. Ice-cream freezers as shown in Fig. 223 find a ready sale.

FIG. 222. — Coffee grinder.

FIG. 223. — Ice-cream freezer.

The factory trade offers the best field for special apparatus. Motor-driven apparatus is legion. It would require a large

volume to partially describe the different kinds of motor driven apparatus. Manufacturers of machinery can be relied on to furnish proper data, etc., as to motor drive of machines of their manufacture. Or manufacturers of electric motors will readily furnish the necessary bulletins and information to enable a contractor to properly present the matter to his customer. In Chapter VIII a number of motor applications are illustrated. The local illuminating company can generally be relied on to assist in making a sale, as day loads are particularly desirable to them.

Electrical heating devices for manufacturing devices are a good substitute for gas heated apparatus. The contractor

FIG. 224.—Soldering iron.

FIG. 225. — Glue pot.

should consult with specialists in this line when working up a big job. The hat factory and printing plant are good fields for this line of apparatus, which is specially constructed to meet specific conditions. In large installations the alternating current, transformed down to 20 volts, is the most satisfactory.

The electrical soldering iron, Fig. 224, glue pot, Fig. 225, are standard devices salable to a wide range of customers.

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